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FOREWORD

In December 1969, the Departments of Agricultural Economics, U. P. College of Agriculture and The International Rice Research Institute jointly sponsored two seminars on rice consumption and marketing and on rice production. This volume contains papers presented at the second of these conferences. Only minor revisions have been made so that they could be made available to those interested without delay.

The seminars held in 1969 represent the fourth and fifth in a series of jointly sponsored conferences in economics held in Los Baños over the past few years. The first, entitled "Savings and Capital Accumulation in Philippine Agriculture" was held on April 24-25, 1964. The second, "Growth of Output in the Philippines" was held on December 9-10, 1966. The third, "The Economics of Rice Production" was held on December 8-9, 1967. The papers from the previous three conferences are published in the Second Semester 1964 and First and Second Semesters 1968 issues of The Philippine Economic Journal.

Jesus C. Sta. Iglesia
For the U. P. College of Agriculture

Randolph Barker
For The International Rice Research Institute

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THE SHIFT TO NEW RICE VARIETIES IN THE PHILIPPINES

Leonardo A. Paulino and Levy A. Trinidad [1]

1.0 INTRODUCTION

The use of new rice varieties in the Philippines has been receiving a big boost through an active government support that started in 1966. Since then a significant shift of the country's palay farms to these varieties has occurred. Survey data for crop years 1968 and 1969 show that palay crop area planted to the varieties developed at the International Rice Research Institute (IR series) increased by 109.9 percent; to those produced by the experiment stations of the Bureau of Plant Industry (BPI series), by 14.9 percent; and to the varieties developed at the U. P. College of Agriculture (College series), by 774.4 percent. The area reported in both crop years for traditional varieties indicates a decrease of 23.9 percent. With evident advantage of an early start, the area under the IR series in 1968 already reached 428,000 hectares while that reported for the BPI series was 255,000 hectares; and the College series, 18,000 hectares.

Available data clearly reflect a decrease in the average yield per hectare of the drought-affected 1969 crop which was less by 2.5 percent compared to the previous year's harvest. Such decline in output could have been much more had less farmers shifted to the new varieties. The area planted to the new high-yielding varieties increased tremendously. For the IR series alone, the reported hectarage more than doubled that of the previous year as it rose from 428,570 hectares in 1968 to about 899,530 hectares in 1969. Palay area under the BPI series increased from 254,670 to 292,580 hectares during the same period. Most evident was the increase in College series plantings - area expanded from just about 18,260 hectares to a total of 159,660 hectares within one crop year alone. This significant spread of the College series appears to show that farmers are now realizing that quality product brings more income. Considering price differentials, such increased income could even surpass that from a bigger yield afforded by the IR series when it comes to profits earned by farmers. (Table 1)

There is also evidence that our farmers are more conscious of the kind of varieties to plant. Definitely, they have been influenced by the successful results of demonstration plots of both government personnel and agents of private firms dealing in production inputs for farm use. Farmers are now being convinced of the shift from the traditional to the new varieties.

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[1] Director and Assistant Director for Research, Bureau of Agricultural Economics, Department of Agriculture and Natural Resources.

2.0 SHIFTING OF PRIORITY AREAS

Table 2 shows the palay area, production, and yield per hectare of the first priority provinces[2] in 1968 and 1969. Increases in the area planted to the new varieties in 1969 over that of 1968 were 127 percent for the IR series, 48 percent for the BPI series, and 943 percent for the College series. These high-yielding varieties had an overall increase of 121.2 percent in these provinces. On the other hand, hectarage for the traditional varieties decreased by 32 percent (see Table 3).

Output increases were achieved from the use of high-yielding varieties, but average yields per hectare decreased (Table 2). These decreases were, however, partly the result of the protracted drought in 1969 to which high-yielding varieties seem sensitive. The College series suffered the largest decline in yield per hectare, by about 19 cavans. It is also likely that this decrease was partly due to expansion in area planted. An overall decrease in yield of one cavan per hectare of these high-yielding varieties occurred in 1969. It is also worth noting that during the period, the traditional rice varieties still covered more than half of the total palay area planted in the province.

Increases in both area and yield of rice farms which planted new varieties were also reported in areas outside of the first priority provinces.

In the second priority provinces,[3] data on palay area reflect the farmers' growing preference for planting quality varieties, specifically the College series. Hectarage under this series very significantly increased by 1,083 percent. The area planted to the IR series increased by 92 percent. On the other hand, hectarage for the BPI series showed a decrease of 12 percent, which decline was probably due to shiftings to the College series (see Table 3).

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[2] The first priority provinces are: Bataan, Bulacan, Cagayan, Camarines Sur, Cotabato, Iloilo, Isabela, Laguna, Leyte, Mindoro Oriental, Nueva Ecija, Nueva Vizcaya, Pampanga, Pangasinan and Tarlac.

[3] Second priority are: Aklan, Albay, Antique, Batangas, Bukidnon, Camarines Norte, Cavite, Lanao del Norte, Davao del Sur, Ilocus Sur, Ilocos Norte, Lanao del Sur, La Union, Leyte del Sur, Misamis Occidental, Negros Occidental, Quezon, Rizal, Sorsogon, Zambales, Zamboanga del Norte and Zamboanga del Sur.

3.0 SPREAD OF HIGH-YIELDING VARIETIES OF PALAY IN THE PROVINCE OF NUEVA ECIJA

Nueva Ecija is one of the first priority provinces under the government rice production program and it accounts for 30 percent of the palay output of Central Luzon. The province is significant to the development of the rice industry, particularly to the national rice production program. Assessments of the different aspects of the national rice program in this province would, therefore, provide yardsticks for evaluating the program as a whole. One such aspect is the spread of high-yielding varieties of rice in the province.

3.1 Methodology

For this study, the Bureau of Agricultural Economics obtained data for 67 sample barrios out of the total of around 600 barrios in the province. For purposes of delineation, these barrios were grouped into "program" and "non-program" barrios under a first priority province of the national rice production program. Since Nueva Ecija is also a major area under the Land Reform Program, a third classification was made for comparison purposes. For this paper, however, barrios falling under the third group can be merged with those falling under the "program"[4] barrios. In order to lessen variability among barrios, each of these two groups of barrios was further stratified according to estimated palay area.

Within each "program" barrio, the farming households were grouped into "cooperators"[5] and "non-cooperators". As in other first priority provinces of the rice production program, the sampling fractions applied to Nueva Ecija were 1/5 for the "program" barrios (same rate for Land Reform barrios) and 1/15 for the "non-program" barrios. One out of every 15 farming households in the related sample barrio served as respondent in the Bureau surveys. A total of 380 sample farm households furnished the basic data.

3.2 Findings

Table 4 presents the area, production, and yield per hectare of palay in Nueva Ecija for the high-yielding variety (HYV) group and the traditional variety group in 1968 and 1969. It will be noted that the high-yielding varieties accounted for about 1/8 of the palay area in the province during the 1968 crop year. The HYV's contributed about 16 percent of the palay output of Nueva Ecija for that year. The overall average yield per hectare of HYV's in the province in 1968 was estimated at 51.7 sacks of 44 kilograms each compared to 38.8 sacks of the traditional varieties.

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[4] By definition, a "program" barrio is one covered by the current rice and corn self-sufficiency program as reported by the Rice and Corn Productivity Coordinating Council (RCPCC) provincial directors and/or production technicians.

[5] A "program cooperator" is the head of the farm household included in the master list of cooperators as submitted by the production technicians of the RCPCC.

The area planted to HYV's in the province during the following year increased to 60,900 hectares or 34.2 percent of the palay area in Nueva Ecija in 1969. HYV's accounted for 41.6 percent of the palay output of the province in the same year. The yield per hectare of HYV's that year declined by only 1.7 sacks per hectare, as compared to a drop of 2.4 sacks for the traditional varieties. The table shows that the yields per hectare of the high-yielding and of the traditional varieties in Nueva Ecija in 1969 were 50.0 sacks and 36.4 sacks, respectively.

Inasmuch as the IR series pre-dated the other recommended varieties, it would be of interest to cite the data obtained for the IR varieties. During the crop year 1968, IR varieties accounted for 10 percent of the palay area in the province and 13.2 percent of the palay output. These varieties showed an estimated average yield per hectare of 53.4 sacks in 1968. During the following year the area planted to the IR series more than doubled and accounted for an estimated 25 percent of the palay area in Nueva Ecija, producing about 31 percent of the total palay production of the province in 1969. A sizable decline in average yield per hectare of 2.5 sacks (from 53.4 sacks per hectare to 50.9 sacks per hectare) between 1968 and 1969 is, however, indicated by the available data.

The drought that affected the country during that year did not appear to have very seriously damaged the palay crop in Nueva Ecija. Granting that the yields per hectare in 1968 were maintained in 1969, the province would have produced an additional half a million sacks or only 6.5 percent of the estimated normal output for that year. It is especially interesting to note from Table 4 that while both HYV's and the traditional varieties underwent declines in average yield per hectare as a result of the drought, the over-all yield per hectare for the province rose from 40.4 to 41.1 sacks. This is obviously the result of the increased contribution of the HYV's which offset a probable decline.

Table 5 indicates the magnitude of change undergone by the HYV's and the traditional varieties during the crop years under comparison. HYV-reported areas in Nueva Ecija rose by 165 percent while those for traditional varieties declined by 28 percent. Areas accounted for by IR varieties, in particular, increased by 140 percent. The same trends are exhibited by the production figures. The corresponding changes in yield per hectare by the variety groups from 1968 to 1969, can also be observed by comparing the percentage changes in area and production for each variety group.

A distribution of the sample barrios in the province, according to the estimated yield per hectare of the variety groups, by range, for the two crop years is shown in Table 6. The weighted percentages of the entries, considering the sampling probabilities of the barrios falling opposite each yield category, have been computed for a better presentation of distribution. One easily notes that the majority of barrios reported yields of traditional varieties in the 40-60 sacks per hectare range in both crop years. On the other hand, the modal class of barrios which reported HYV's in 1969 was at the 60-80 sacks per hectare range, where 14 percent of the barrios were entered. During the following year, the modal class shifted to one category lower, the 40-60 sacks per hectare range where 22 percent of the barrios clustered.

The increase in the number of barrios that reported plantings of HYV's from 1968 to 1969 is well pointed out by the 0 category. Fifty-nine percent of the barrios of Nueva Ecija gave no indication of HYV plantings in 1968. In 1969, however, 48 percent of the barrios, or a drop of 11 percent, did not report HYV varieties. Conversely, 52 percent or more than half of the barrios in the province reported HYV plantings in crop year 1969.

This study indicates the shifting from traditional varieties to high-yielding varieties in the province of Nueva Ecija as seen from an increase of 65 percent or about 38,000 hectares in hectarage between 1968 and 1969. This increase could have been largely accounted for by 12 barrios in the province (or 18.5 percent of the total number of barrios under study) which reported HYV areas for 1969 but none for 1968. Expansion in HYV area could have also contributed to this increase. Of the 27 barrios (or 34.5 percent of the total) reporting HYV for both years, 22.7 percent indicated expansion in HYV hectarage (see Table 7).

The 2 percent decrease in total production is believed to have been minimized by the HYV's without which decline was likely to be greater. This was also true for overall yield per hectare which increased despite the drought in 1969.

4.0 EFFECTS OF IRRIGATION ON YIELD PER HECTARE

In view of some inconsistent data on yields of the improved and the traditional varieties, especially in the priority areas, more detailed analysis was found necessary. As it is quite possible that yields may be affected by the cultural practices prevailing within each area, a breakdown of the varieties under irrigated and non-irrigated areas was made for each region.

Data for 1968 show that the area planted to the lowland irrigated palay crop had an average yield of 39.6 cavans per hectare. This is higher than that of lowland non-irrigated areas which was 28.4 cavans per hectare. It will be noted that lowland non-irrigated areas planted to traditional varieties gave almost the same average yield as the non-irrigated areas planted to both traditional and high-yielding varieties. The yield of the irrigated areas for traditional varieties differed from the overall yield of irrigated areas by only 3 cavans per hectare. Average yields for the IR series were 45.5 cavans per hectare and 33.4 cavans per hectare, respectively, for the irrigated and non-irrigated crops (Table 8). Those of the BPI series were 42.6 cavans per hectare for the irrigated area and 27.3 cavans per hectare for the non-irrigated area (Table 9). Among the different varieties, the largest difference in yield between the irrigated and non-irrigated areas was exhibited by the College series. Yields of 51.3 cavans and 20.1 cavans per hectare, respectively, or a difference of about 31 cavans per hectare was reported (Table 10).

With the above-mentioned data on yields of the non-irrigated and irrigated areas, one might conclude that the advantage in yield derived from irrigation in the regular season may not be very significant. The income accruing from the yield increases due to irrigation may not even be enough to cover the costs of irrigation. This is particularly true of deep-well pump irrigation. However, the use of gravity irrigation facilities and shallow well irrigation pumps may enable recovery of irrigation costs, since the inputs necessary for the cultivation of recommended varieties are complementary to this type of irrigation. From a farmer's standpoint, the use of recommended varieties may not be justifiable at all as far as his profit is concerned, since actual yield performance may not recover part of his added costs. However, from the national standpoint, recommended varieties have improved returns to farmers because these are high yielders. The differences in market prices are, however, overlooked.

The planting of traditional varieties appears to decrease as reflected by the overall decline in area from 2,602,160 hectares in 1968 to 1,980,380 hectares in 1969. Taken as a sign of increasing acceptance of the new varieties, this decline has become the ground for generalizations that the traditional varieties are on the way out. However, it should not be ignored that the farmers will someday start weighing the benefits between the use of traditional varieties and of the high-yielding varieties from the standpoint of market prices. Traditional varieties like Milagrosa, Binuhangin, and others might be more profitable than the new varieties, considering the prices that these varieties command in the market. Prices of traditional varieties tend to be stable, wide price differentials being exhibited only in two or three trading areas.

5.0 FACTORS AFFECTING FARMERS' SHIFT TO NEW RICE VARIETIES

It will be seen that there are actually several factors affecting the shift of varieties from the traditional to the new. Of major importance is the difference in price; not all of the recommended varieties command good prices in the market. A specific example is the IR-8 variety. The low prices that it commands in the market may lead farmers utilizing this variety to shift back to traditional varieties or to other new varieties. In terms of total returns, farmers may still benefit from the new varieties because of bigger yields, but many tend to disregard this viewpoint. Farmers are quick to react unfavorably to low prices.

Secondly, there are farmers who are readily influenced by successful results of demonstrations on variety shifts in neighbor farms. These farmers shift varieties without considering difference in resources between farms. With insufficient resources for the culture of the recommended varieties, low yields could be expected despite their advantage in productivity. When this occurs, these farmers then revert to other types whose culture require utilization of less resources. More often than not, the shift is to the traditional varieties since resources are usually only enough for these.

A third factor that has greatly influenced the initial shifting of rice cultivation to that of new varieties is the involvement of government extension services in the introduction of these. In addition to imparting progressive methods of rice culture, these agents are able to provide part of the resources needed by the farmers. This is because extension agents also assume promotional functions for private firms dealing in farm inputs. The utilization of government extension personnel by these private firms to promote their input products has, to a large extent, influenced the acceptance of recommended varieties. Furthermore, the omniscience with which government extension personnel are regarded by the farmers has facilitated the spread of the new varieties.

Finally, many farmers are becoming receptive to change. They have become less resistant to the introduction of new palay varieties and cultural practices, and discriminating in the choice of varieties to plant. However, it is also these same farmers who are business-conscious and market prices would greatly influence their decisions. As has been previously indicated, the traditional varieties command better prices than the original improved varieties; and the planting of these low-priced kinds may not be for long.

Based on the foregoing arguments, one may be led to pose this question: To what extent do farmers revert to the traditional varieties as dictated by market price? The answer would depend on a study of data of individual farms.

TABLE 1. Summary: Area and production of recommended and traditional palay varieties, Philippines, crop years 1967/68 and 1968/69.

Variety	Area		Percent increase or (decrease)	Production		Percent increase or (decrease)
	1968	1969		1968	1969	
	Hectare			1000 sacks of 44 kgs.		
High-yielding varieties:						
IR series	428,570	899,530	109.9	18,271	33,910	85.6
BPI series	254,670	292,580	14.9	8,562	8,519	(0.5)
College series	18,260	159,660	774.4	719	5,696	692.3
Traditional varieties	2,602,160	1,980,380	(23.9)	76,100	52,889	(30.5)

TABLE 2. Area, production and yield per hectare of recommended and traditional palay varieties in the RCPCC Priority I and II Provinces, Philippines, crop years 1967/68 and 1968/69.

Variety	Area		Production		Yield per hectare	
	1968	1969	1968	1969	1968	1969
	Hectare		1000 sacks of 44 kgs.		Sacks of 44 kgs.	
Priority I						
High-yielding varieties						
IR series	251,920	572,960	11,022	22,211	43.75	38.75
BPI series	112,040	165,330	3,100	3,949	27.67	23.88
College series	8,120	84,680	433	2,925	53.36	34.54
Traditional varieties	1,353,750	915,040	41,713	25,838	30.81	28.24
Priority II						
High-yielding varieties						
IR series	113,120	216,910	5,195	9,034	45.93	41.65
BPI series	96,690	85,520	4,054	3,210	41.93	37.53
College series	4,110	48,630	183	1,857	44.60	38.18
Traditional varieties	702,940	586,390	20,197	15,282	28,73	26.06

TABLE 3. Percentage changes in area, production and yield per hectare of recommended and traditional palay varieties in the RCPCC Priority I and II Provinces, 1969 over 1968, Philippines.

Variety	Area	Production	Yield per hectare
Priority I			
High-yielding varieties:			
IR series	127.4	101.5	(11.4)
BPI series	48.6	27.4	(13.7)
College series	942.9	575.0	(35.3)
Traditional varieties	(32.4)	(38.1)	(8.3)
Priority II			
High-yielding varieties :			
IR series	91.7	73.9	(9.3)
BPI series	11.5	(20.8)	(10.5)
College series	1083.2	913.9	(14.4)
Traditional varieties	(15.87)	(24.3)	(9.3)

TABLE 4. Palay area, production and yield per hectare in Nueva Ecija, by major variety group, crop years 1967/68 and 1968/69.

Variety group	Area (Hectares)		Production (1000 sacks of 44 kgs.)		Yield/hectare (44 kgm. sacks)
1968					
HYV's	22,960	(12.4)	1,187	(15.9)	51.7
Traditional	162,380	(87.6)	6,295	(84.1)	38.8
Total	185,340	(100.0)	7,482	(100.0)	40.4
1969					
HYV's	60,900	(34.2)	3,046	(41.6)	50.0
Traditional	117,330	(65.8)	4,272	(58.4)	36.4
Total	178,230	(100.0)	7,318	(100.0)	41.1
IR					
1968	18,550	(10.0)	991	(13.2)	53.4
1969	44,520	(25.0)	2,267	(31.0)	50.9

Note: Figures in parentheses are percentages of year totals.

TABLE 5. Changes in palay area and production in Nueva Ecija by major variety groups, crop years 1967/68 and 1968/69.

Variety groups	Area			Production		
	1968	1969	Change	1968	1969	Change
	hectares	hectares	percent	1000 sacks of 44 kgs.	1000 sacks of 44 kgs.	percent
HYV's	22,960	60,900	165	1,187	3,046	157
Traditional	162,380	117,330	(28)	6,295	4,272	(32)
All varieties	185,340	170,230	(4)	7,482	7,318	(2)
IR	18,550	44,520	140	991	2,267	129

TABLE 6. Distribution of Nueva Ecija sample barrios according to palay yields per hectare, by variety group, crop years 1967/68 and 1968/69.

Yield per hectare	High-yielding varieties				Traditional varieties			
	1968		1969		1968		1969	
Sacks	Number		Number		Number		Number	
0a/	35	(59)	28	(28)	0	(0)	2	(1)
Below 20	1	(3)	1	(3)	0	(0)	1	(3)
20 - 40	8	(10)	10	(13)	22	(32)	18	(25)
40 - 60	8	(10)	16	(22)	37	(56)	33	(53)
60 - 80	13	(14)	10	(12)	7	(11)	12	(15)
80 - 100	1	(1)	1	(3)	1	(1)	1	(3)
Above 100	1	(3)	1	(1)	0	(0)	0	(0)
Total	67	(100)	67	(100)	67	(100)	67	(100)

a/ For sample barrios that reported no palay hectarage.

Note: Figures in parentheses are weighted percentages of number totals.

TABLE 7. Distribution of sample barrios in Nueva Ecija based on the reported palay area planted to HYV in crop years 1967/68 and 1968/69.

HYV Palay area	Program barrios	Non-program barrios	Total[a/]	
	Number	Number	Number	
1. No HYV reported for both 1968 and 1969	10	13	23	(41.2)
2. With reported HYV area in 1968 but none in 1969	4	1	5	(5.8)
3. With reported HYV area in 1969 but none in 1968	7	5	12	(18.5)
4. With reported HYV area for both 1967/68 and 1969	20	7	27	(34.5)
(a) Larger in 1969	(12)	(5)	(17)	(22.7)
(b) Smaller in 1969	(7)	(2)	(9)	(10.9)
(c) Unchanged	(1)	(0)	(1)	(0.9)

a/ Second column of figures in parentheses are weighted percentages of number total.

TABLE 8. Palay, IR series: Area and yield per hectare by region, Philippines Crop Years 1967/68 and 1968/69.

Region	Area (1000 hectare)						Yield (sack of 44 kgs.)					
	Irrigated			Non-irrigated			Irrigated			Non-irrigated		
	1968	1969	Percent incr. or (decrease)	1968	1969	Percent incr. or (decrease)	1968	1969	Percent incr. or (decrease)	1968	1969	Percent incr. or (decrease)
Philippines	329	682	108.2	100	216	115.3	45.5	41.2	(9.5)	33.4	26.6	(20.4)
Ilocos	18	16	(10.6)	7	11	60.5	60.9	56.6	(7.1)	53.5	45.6	(14.8)
Cagayan Valley	20	26	28.3	2	10	304.0	55.4	52.4	(5.4)	43.6	19.4	(55.5)
Central Luzon	81	142	75.6	11	42	280.6	51.9	53.6	3.3	40.5	41.2	1.7
Southern Tagalog	74	124	68.5	25	25	(1.4)	38.6	30.8	(20.2)	30.6	17.9	(41.5)
Bicol	41	124	202.6	25	31	24.9	51.8	47.5	(8.3)	38.1	25.1	(34.1)
Eastern Visayas	26	51	99.2	6	21	268.7	26.6	29.1	9.4	14.6	13.2	(9.6)
Western Visayas	15	36	141.4	12	29	143.6	48.6	47.4	(2.5)	28.0	36.8	31.4
N & E Mindanao	16	40	150.7	5	7	53.5	29.4	27.4	(6.8)	12.8	16.4	28.1
S & W Mindanao	38	123	228.3	7	40	434.5	44.1	34.4	(2.0)	29.3	15.5	(46.6)

TABLE 9. Palay, BPI series: Area and yield per hectare by region, Philippines, crop years, 1967/68 and 1968/69.

Region	Area (1000 hectare)						Yield (sack of 44 kgs.)					
	Irrigated			Non-irrigated			Irrigated			Non-irrigated		
	1968	1969	Percent incr. or (decrease)	1968	1969	Percent incr. or (decrease)	1968	1969	Percent incr. or (decrease)	1968	1969	Percent incr. or (decrease)
Philippines	106	114	8.0	148	179	19.8	42.6	37.1	(12.9)	27.3	24.0	(12.1)
Ilocos	9	5	(47.1)	7	3	(59.8)	71.2	59.2	(16.9)	35.4	34.6	(2.3)
Cagayan Valley	5	13	186.5	a/	26	6,533.3	39.4	46.2	17.3	27.4	25.8	(5.8)
Central Luzon	9	6	(26.8)	2	4	146.2	37.6	43.2	14.9	33.5	50.7	51.3
Southern Tagalog	18	31	72.8	13	41	222.3	34.5	20.5	(40.6)	27.8	18.1	(34.9)
Bicol	6	9	42.4	12	9	(29.7)	53.1	49.8	(6.2)	30.8	19.7	(36.0)
Eastern Visayas	11	19	75.5	21	15	(28.7)	46.3	28.5	(38.4)	19.3	13.3	(31.1)
Western Visayas	4	11	164.2	19	36	89.0	40.2	43.3	7.7	32.8	23.0	(29.9)
N & E Mindanao	5	9	75.0	3	2	49.8	16.8	45.9	173.2	19.6	10.5	(46.4)
S & W Mindanao	39	11	(71.8)	71	43	(39.5)	41.6	49.2	18.3	26.8	31.7	18.3

a/ Less than 500 hectares.

TABLE 10. Palay, C-series: Area and yield per hectare by region, Philippines, crop years 1967/68 and 1968/69.

Region	Area (1000 hectare)						Yield (sack of 44 kgs.)					
	Irrigated			Non-irrigated			Irrigated			Non-irrigated		
	1968	1969	Percent incr. or (decrease)	1968	1969	Percent incr. or (decrease)	1968	1969	Percent incr. or (decrease)	1968	1969	Percent incr. or (decrease)
Philippines	11	115	924.0	7	45	733.2	51.3	39.1	(23.8)	20.1	26.7	32.8
Ilocos	a/	3	700.0	-	1	-	41.8	75.2	79.9	-	52.6	-
Cagayan Valley	2	12	638.0	-	8	-	67.1	40.8	(39.2)	-	26.1	-
Central Luzon	4	24	543.6	a/	7	5,466.7	59.3	51.0	(14.0)	108.0	22.0	(79.6)
Southern Tagalog	2	27	1,329.1	1	5	254.9	52.8	31.0	(41.3)	34.2	31.3	(8.5)
Bicol	1	14	1,222.0	-	6	-	37.0	44.2	19.5	-	36.6	
Eastern Visayas	-	4	-	4	4	(2.8)	-	31.6	-	10.8	12.4	14.8
Western Visayas	1	2	34.8	2	4	364.3	44.6	43.0	(3.6)	23.2	24.6	6.0
N & E Mindanao	a/	8	1,733.3	-	9	-	13.8	36.6	165.2	-	27.7	-
S & W Mindanao	1	21	2,578.8	-	1		34.6	29.2	(15.6)	-	6.3	

a/ Less than 500 hectares

TABLE 11. Palay, traditional: Area and yield per hectare, by region, Philippines, crop years 1967/68 and 1968/69.

Region	Area (1000 hectares)						Yield (sack of 44 kgs.)					
	Irrigated			Non-irrigated			Irrigated			Non-irrigated		
	1968	1969	Percent incr. or (decrease)	1968	1969	Percent incr. or (decrease)	1968	1969	Percent incr. or (decrease)	1968	1969	Percent incr. or (decrease)
Philippines	863	560	(35.2)	1,258	967	(23.0)	36.6	36.8	0.5	28.2	24.8	(12.1)
Ilocos	48	34	(29.4)	46	52	12.8	38.4	49.4	28.6	29.0	36.8	26.9
Cagayan Valley	104	77	(26.3)	139	87	(37.5)	38.4	35.2	(8.3)	35.7	19.6	(45.1)
Central Luzon	267	199	(25.4)	247	177	(28.5)	42.8	42.7	(0.2)	38.1	32.4	(15.0)
Southern Tagalog	145	85	(41.6)	168	108	(35.5)	30.5	33.9	11.1	26.6	24.8	(6.8)
Bicol	86	26	(69.3)	96	42	(55.7)	38.5	28.4	(26.2)	20.3	17.3	(14.8)
Eastern Visayas	65	31	(53.0)	184	204	10.8	19.9	26.1	31.2	17.3	17.3	-
Western Visayas	60	56	(6.6)	196	142	(27.3)	45.6	35.6	(21.9)	34.5	30.1	(12.8)
N & E Mindanao	20	30	51.7	51	35	(31.0)	26.8	18.7	(30.2)	19.3	20.2	4.7
S & W Mindanao	68	22	(67.7)	131	120	(8.0)	29.8	33.6	12.8	18.8	22.2	18.1

TABLE 12. Irrigated lowland crop: Area and yield per hectare of recommended and traditional palay varieties, Philippines, crop years 1967/68 and 1968/69.

Variety	Area		Percent increase or (decrease)	Yield per hectare		Percent increase or (decrease)
	1968	1969		1968	1969	
	Hectare			Sacks of 44 kgs.		
High-yielding varieties:						
IR series	328,180	683,370	108.2	45.5	41.2	(9.5)
BPI series	105,630	114,080	8.0	42.6	37.1	(12.9)
College series	11,270	115,400	924.0	51.3	39.1	(23.8)
Traditional varieties	863,940	569,970	(34.0)	36.6	36.8	0.5

TABLE 13. Non-irrigated lowland crop: Area and yield per hectare of recommended and traditional palay varieties, Philippines, crop years 1967/68 and 1968/69.

Variety	Area		Percent increase or (decrease)	Yield per hectare		Percent increase or (decrease)
	1968	1969		1968	1969	
High-yielding varieties:						
IR series	100,390	216,160	115.3	33.4	26.6	(20.4)
BPI series	149,040	178,500	19.8	27.3	24.0	(12.1)
College series	6,990	44,260	733.2	20.1	26.7	32.8
Traditional varieties	1,257,600	967,870	(23.0)	28.2	24.8	(12.1)

SPATIAL ASPECTS OF HYV DIFFUSION

Robert E. Huke and James Duncan[1]

1.0 INTRODUCTION

In June of 1966, the International Rice Research Institute (IRRI) turned over to the Philippine Government 50 tons of IR8 seed. This was the first significant volume of seed for the new short stature, high yielding plant type to become available for use outside of experimental farms. When distributed a few weeks later by various government agencies, it formed the bulk of the original widespread planting of "miracle rice." In addition to the 50 tons of seed distributed by various government agencies, IRRI itself distributed the remaining 5 tons of seed, in two-kilogram samples, to the first 2,359 farmers to request such seed in person at the Institute.

The government seed was distributed through the Bureau of Plant Industry, the Rice and Corn Administration, the Rice and Corn Production Coordinating Council and the various Provincial Agricultural Officers. It was generally allotted in units of 8 cavans per farmer or approximately sufficient seed for 10 hectares. The IRRI-distributed seed, by contrast, was sufficient for only about 700 square meters per farmer. Both the government seed and the IRRI seed found its way to all parts of the country, with Central Luzon receiving somewhat more than a proportional share. Within this region, a further modest concentration of the "miracle rice" seed developed in the province of Nueva Ecija. Even here, however, the total IR8 available in July 1966 was adequate at very efficient use, for the planting of only 811 ha. Sixty-seven farmers in Nueva Ecija had government seed sufficient for a total of 800 ha. of land while 158 farmers had IRRI seed sufficient for 11 ha. Both the number of farmers involved and the area of land planted was well below one-half of 1 percent of the rice land totals even in the province where the seed concentration was highest.

The impact of this modest beginning has been great. In July of 1969, just 3 years after the first planting of IR8 in Nueva Ecija, the process of diffusion had carried "miracle rice" and other high yielding varieties to approximately 40 percent of the province's total rice area. This paper represents an attempt to map the spread of HYV[2] in a portion of Nueva Ecija and to identify some of the spatial factors which influenced that diffusion.

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[1] Professor Huke is a Visiting Scientist at the International Rice Research Institute, on leave from the Department of Geography, Dartmouth College. Mr. Duncan, a senior at Dartmouth College, acted as Research Assistant for this project.

[2] For purposes of this paper, the term "HYV (high yielding varieties)" is limited to three varieties: IR8, IR5 and C4. Others sometimes considered as HYV such as BPI-76 and C-18 were not included because field investigation showed that their impact in the study area had been negligible.

2.0 THE SETTING

The study area is a single municipality, one of 30 similar political subdivisions of the province. The municipality is in turn divided into 11 administrative units, the poblacion (town proper) and 10 barrios (villages). Data for this investigation was collected at the barrio level and was collected from the entire population without the use of sampling techniques. The decision to work at the micro-scale rather than at a macro- or intermediate scale was deliberate and was based on several considerations. Data at the barrio level within a single municipality is far more uniform than in data between municipalities at the provincial level or between provinces at the regional level. In addition, apparent inconsistencies in the data for a micro-study could be checked in the field with relative ease while missing data could be collected in the same manner. Such alternatives do not normally exist for a study at the macro-scale.

The final choice of study location was based on several considerations. It was important to find a municipality with as long as history as possible of use of IR[3] rice varieties, one in which there had been a significant introduction of IR8[4] in July 1966. The site should have relatively easy access to facilitate the job of data collection and it should have a relatively uniform physical base. An area with a good data base already established would be highly desirable. Further, an area whose major "central place" was highly eccentric to the total area was desired. This latter requirement was based on the preconception that the poblacion would act as the center and that the rate of innovation would decrease concentrically from this center. An off center poblacion would provide a greater variation in distance across which to test this hypothesis than would a centrally located "central place." The municipality of Gapan satisfied all of these requirements.

Gapan is the southernmost town of Nueva Ecija, bordering on San Miguel, Bulacan. It is one of the longest settled portions of Nueva Ecija and has a total population of slightly over 35,000 persons in an area of just over 13,000 ha. Population density is somewhat higher than that of the province as a whole. Fifty-five percent of the gross area is farmed by 2,217 farmers, resulting in an average farm size of slightly over 3 ha. This is small by provincial standards.

The relatively small farm size, long history and high population density were reflected by a high rate of share tenancy which, according to the 1960 Census, was 87 percent.

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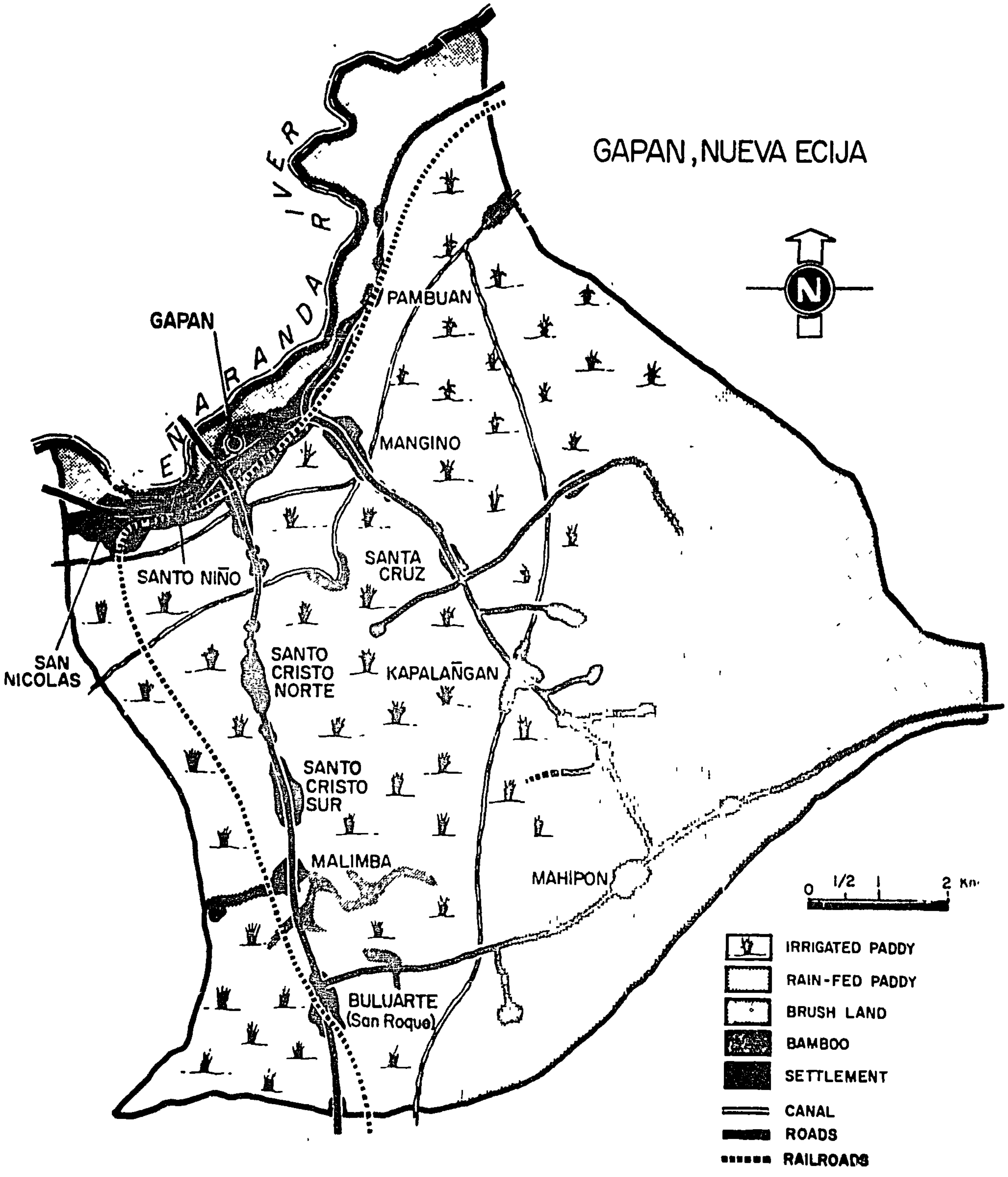
[3] Varieties developed chiefly for their high yields by the International Rice Research Institute, Los Baños, Laguna, Philippines.

[4] In July 1966, this was known simply as "a high yielding IRRI selection" with the code name IR8-288-3. It was officially named IR8 in November 1966.


GAPAN, NUEVA ECIJA
N
PEÑARANDA RIVER
GAPAN
PAMBUAN
MANGINO
SANTO NIÑO
SAN NICOLAS
SANTA CRUZ
SANTO CRISTO NORTE
KAPALAÑGAN
SANTO CRISTO SUR
MALIMBA
MAHIPON
BULUARTE (San Roque)
0 1/2 1 2 Km
IRRIGATED PADDY
RAIN-FED PADDY
BRUSH LAND
BAMBOO
SETTLEMENT
CANAL
ROADS
RAILROADS

Map No. 1

By reputation, both within Nueva Ecija and in neighboring provinces, Gapan is known as a town of progressive farmers. Perhaps one reason for this reputation is the fact that Gapan is served by the Peñaranda River Irrigation System and is on that portion of the system with the most reliable two crop water supply in the entire region. Two-thirds of all farm area in Gapan is so served. The only land depending on rainfall alone is confined to the southeastern portion of the municipality, that area most remote from the poblacion.

Gapan was declared a land reform area on August 7, 1964 and was the second municipality in the nation so designated. Immediately thereafter, a Land Reform Field Office was established in the poblacion and a field worker was assigned to collect data at each barrio unit. Data on farm size, tenure and yield has been tabulated for each season since 1964 by a full time statistician. Data for this study was obtained chiefly from the records of the Land Reform Office of Gapan. However, data for all barrios was spot checked in the field and in the case of two barrios for which data did not appear to be reliable, the information for each farm was checked by interview.

The shape of the municipality is roughly that of a parallelogram with the poblacion immediately adjacent to the northern border and very close to the northwestern corner. A well maintained and fully paved national highway traverses the municipality in a north-south orientation, passing through the poblacion and keeping roughly 2 kilometers east of the municipality's western border. Dirt roads parallel the area's northern and southern borders while a third dirt road parallels the national highway and roughly bisects the study area. All barrios are on one or the other of these roads while a number of sitios (hamlets) are connected to the network by short feeder roads. Motorized tricycles, jeeps and calesas provide transport connections from all barrios to the poblacion.

The influence of the poblacion as a center for innovation for even the most remote barrio is illustrated by the results of an intensive survey of 98 randomly selected farmers in Gapan.[5] These farmers were asked where they obtained various agricultural inputs and where their product was sold. In only one case did a farmer name any location other than Gapan or his own barrio. The "centrality of place" of Gapan's poblacion is further emphasized by the relative size and location of the surrounding poblacions. San Isidro, San Leonardo and Peñaranda to the west, north, and east, respectively, are significantly smaller than Gapan in population and lack Gapan's major market function. San Miguel to the south, involves much further travel and is across a provincial boundary. Final evidence was obtained from a sunvey of road turnings along the dirt roads near the borders of the municipality. This survey indicated a strong preference for the route leading most directly to Gapan.

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[5] See: Benjamin Gaon. The Philippine Land Reform Program: Its Effects on Productivity and Farm Income. Dept. of Agricultural Economics, International Rice Research Institute, M.S. Thesis, in press.

3.0 THE SPREAD OF HYV

Maps 2 through 5 show the spread of HYV in Gapan starting with the introduction of the new rice in July 1966 and continuing at one year intervals through the crop harvested in November 1969. In Gapan, the May-June to October crop is called palagad because, although it grows during the rainy season, it is planted during the dry season with the aid of irrigation. The November to March crop could not grow without irrigation but because it is planted while the weather is still rainy, it is now locally at the regular crop.

IR8, the first of the HYV was released in June-July 1966 and was planted immediately by those farmers in Gapan who received seed. This timing corresponded to the palagad season in Gapan and all maps of the spread of HYV in this study relate to the palagad crop of successive years.

In 1966, three land owners, all living in the poblacion, were each alloted 8 cavans[6] of IR8 seed. One owner divided his seed among four of his tenants, a second divided his seed three ways and the third gave 4 cavans to each of two farmers. Thus, 24 cavans were divided between nine farmers.

The provincial agriculturist provided 30 gantas[7] of seed to one farmer and 2 kilos to a second. Five farmers operating land in Gapan received 2 kilos each from IRRI.

A total of 16 of Gapan's farmers had at least a portion of their land planted to IR8 in July 1966. The location of these farms is shown on Map 2. This map of 1966 distribution shows that the "miracle rice" found its way to five of the 10 barrios in the municipality. Two of these, San Nicolas and Mangino, are contiguous with the poblacion. Two others are the closest barrios to the poblacion along the national highway, while the fifth directly adjoins the barrio with the greatest number of innovators. The pattern shows a marked concentration in the northwestern portion of the municipality close to the poblacion. In Mangino, the barrio with the greatest number of innovators and contiguous with the poblacion, all planters of IR8 in 1966 were offered seed by their landlords. Interviews with both of the landlords concerned indicated that in each case they were interested in keeping the seed as close as possible to their homes so that the progress of the rice could be watched carefully. Both landlords also stated that they wanted this very valuable seed planted on their most productive land and cared for by excellent farmers. Thus, seed was offered only to tenants on the "best land" in the barrio closest to the poblacion. Three of the four innovators in Santo Cristo Norte received their seed in the same way and for the same apparent reasons.

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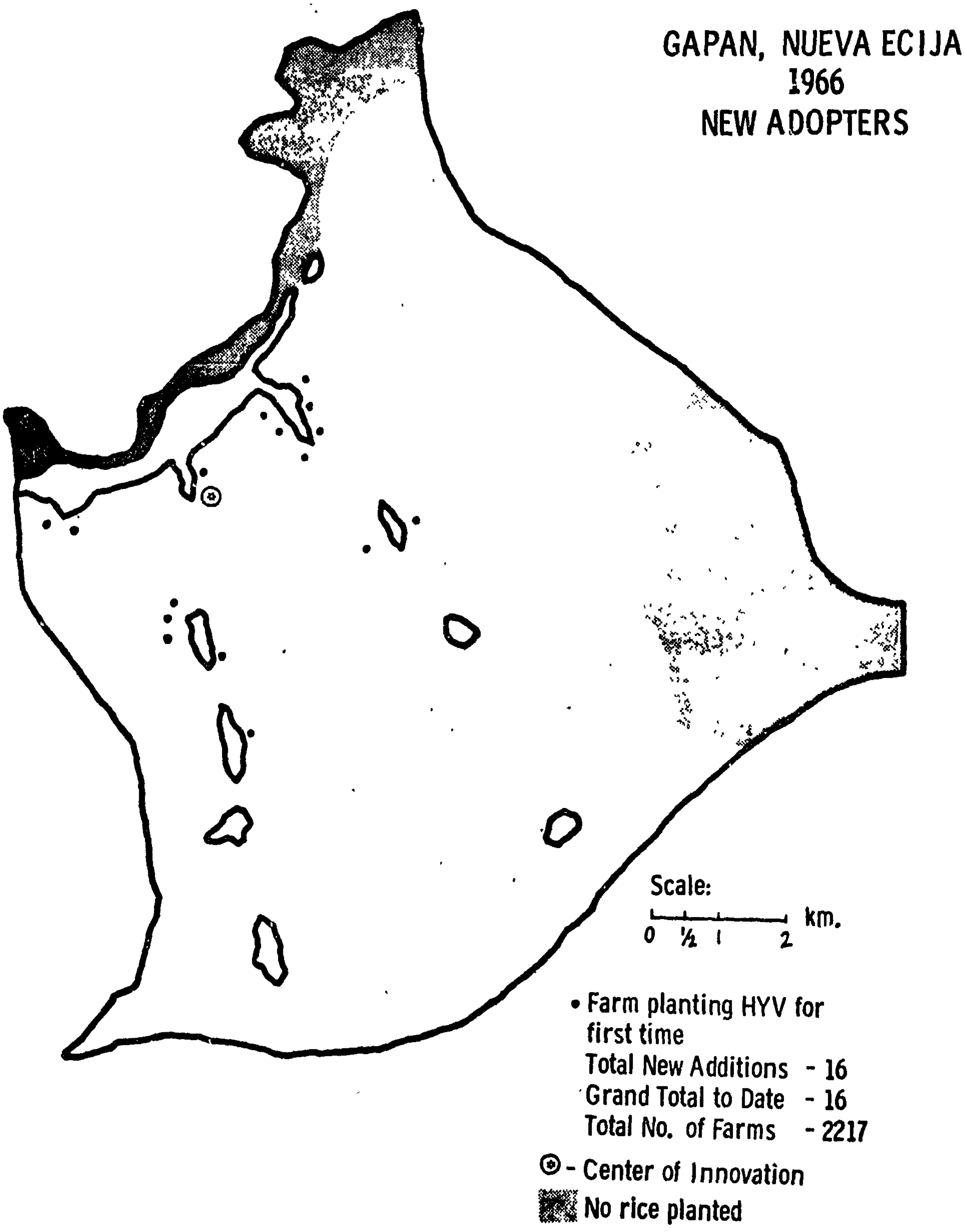
[6] One cavan of seed is equal to 44 kg. With a good germination rate and modest care in transplanting, one cavan of seed will be sufficient to plant 1-1/4 ha.

[7] Twenty-five gantas is equal to one cavan.


GAPAN, NUEVA ECIJA
1966
NEW ADOPTERS
Scale:
0 ½ 1 2 km.
• Farm planting HYV for first time
Total New Additions - 16
Grand Total to Date - 16
Total No. of Farms - 2217
⊙ - Center of Innovation
▨ No rice planted

Map No. 2

Clearly, the pattern of original innovators did not develop by chance but was strongly influenced by the home location of three forward looking and progressive landlords.

Of interest, too, is the fact that both innovators in Santa Cruz as well as the single innovator in Santo Cristo Sur, together representing the three innovating farmers most distant from the poblacion, all obtained their seed from IRRI in Los Baños. The same source provided seed for one planter in Santo Cristo Norte and one in San Nicolas. Of the five farmers who made the trip to Los Baños for seed, one was a large landowner while the others were small scale owner-operators. The two planters provided seed by the Provincial Agriculturist were also owner-operators.

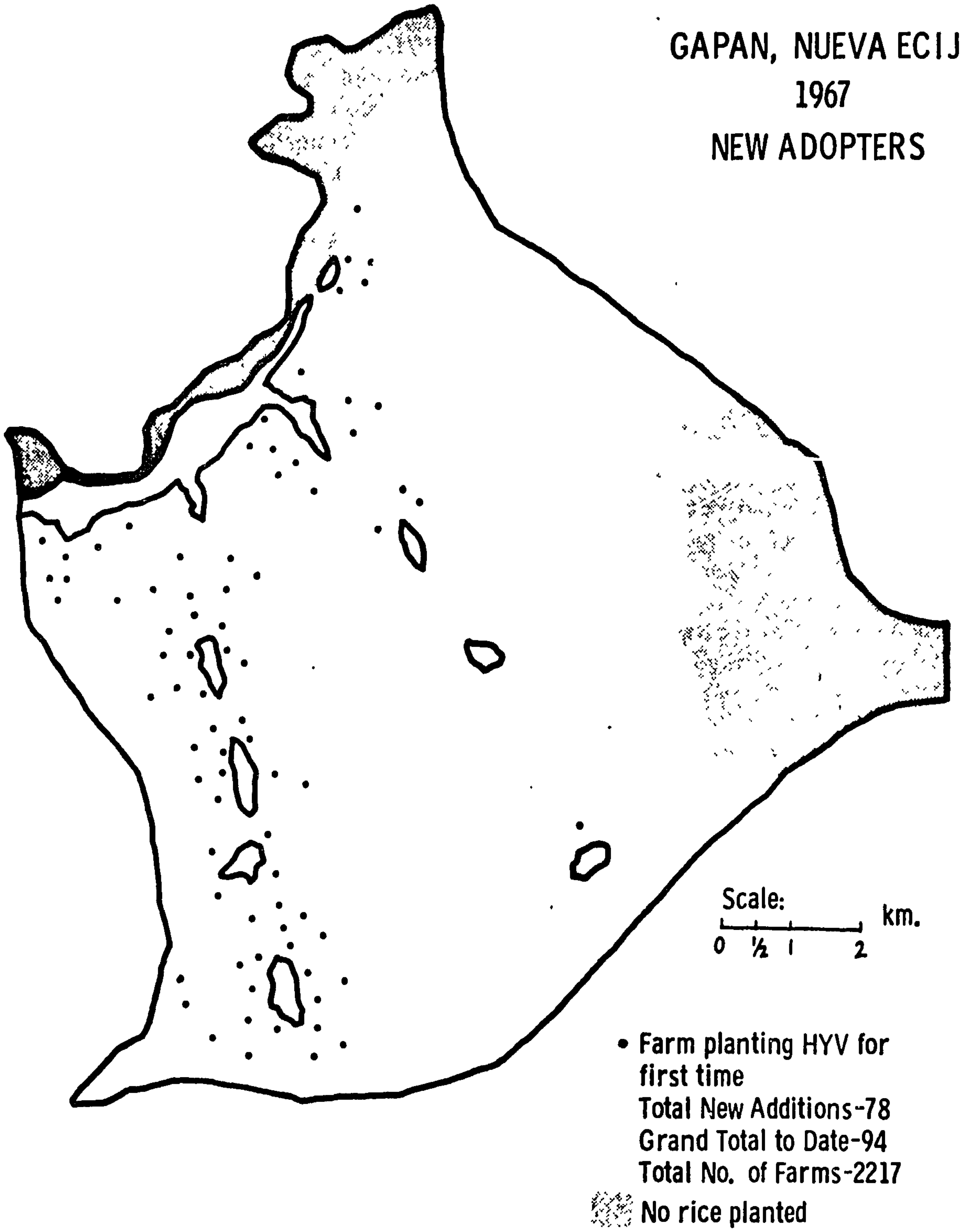
Landowners and owner-operators were the only persons to acquire IR8 seed in Gapan in 1966. Their role as originators of innovation can hardly be questioned.

One year later, the same 16 farmers again planted IR8 and they were joined by 78 new innovators. The farm locations of the new innovators are indicated on Map 3. A study of this map shows that the new innovators were concentrated in two areas: (a) in the same barrios as the previous year, and (b) along the national road south to Malimba and Baluarte. Five new innovators were located in Pambuan, the barrio just east of the poblacion and one in Mahipon in the extreme southeast. The only location with no innovators was the large barrio of Kapalangan, distant from the center and on the dirt road. Considerable spread is evident in the pattern of adoption for 1967 when compared with 1966.

Omitting for a moment the three new innovators in Santa Cruz, 60 percent of the 1967 additions were concentrated in four barrios whose total farm population was only 30 percent of the municipal total. These same four barrios were all centers of innovation in the previous year. In these barrios, the ratio of adoption was double that of the municipality as a whole.

The map for 1968 adoption is striking because of the large number of farmers involved, 25 percent of all farmers in the municipality, and because of the striking similarity between the pattern of this map and that of the previous year. A marked concentration is found in the barrios close to the poblacion and in those barrios along the national highway. On the other hand, Santa Cruz, Kapalangan and Mahipon, with a total of 40 percent of the farm population, had less than 8 percent of 1968 adopters. Such a marked differential in the rate of adoption between these three barrios and the rest of the municipality appears too great to ascribe to distance and the "neighbor effect" alone. This is particularly true when it is recalled that during this period, every barrio had its own land reform field man operating as a "change agent" and extension worker. This map suggests a period of intensification of the earlier pattern and raises the question of why the adoption failed to spread further outward from the center.

Reference to Map 1 and Table 1 provides a possible clue for the apparent resistance to the addition of HYV in Santa Cruz, Kapalangan and Mahipon. In these


GAPAN, NUEVA ECIJA
1967
NEW ADOPTERS
Scale:
km.
0
½
1
2
• Farm planting HYV for first time
Total New Additions-78
Grand Total to Date-94
Total No. of Farms-2217
▨ No rice planted

Map No. 3

TABLE 1. Number of farmers and irrigation, Gapan, 1969.[1]

Barrio	Number of farmers with Irrigated land	Number of farmers with Non-irrigated	Area of rice land (ha) Irrigated land	Area of rice land (ha) Non-irrigated
Sto. Cristo N.	195	0	514	0
Sto. Cristo S.	151	0	421	0
Malimba	88	0	231	0
Baluarte	381	1	1281	10
Kapalangan	85	150	201	539
Mangino	170	3	469	10
Pambuan	220	20	593	55
Mahipon	0	196	0	693
San Nicolas	103	0	229	0
Sta. Cruz	286	282	787	878
Total[2]	1679	652	4726	2185

[1] Source: Land Reform Field Office, Gapan, and Peñaranda River Irrigation System Office, Gapan.

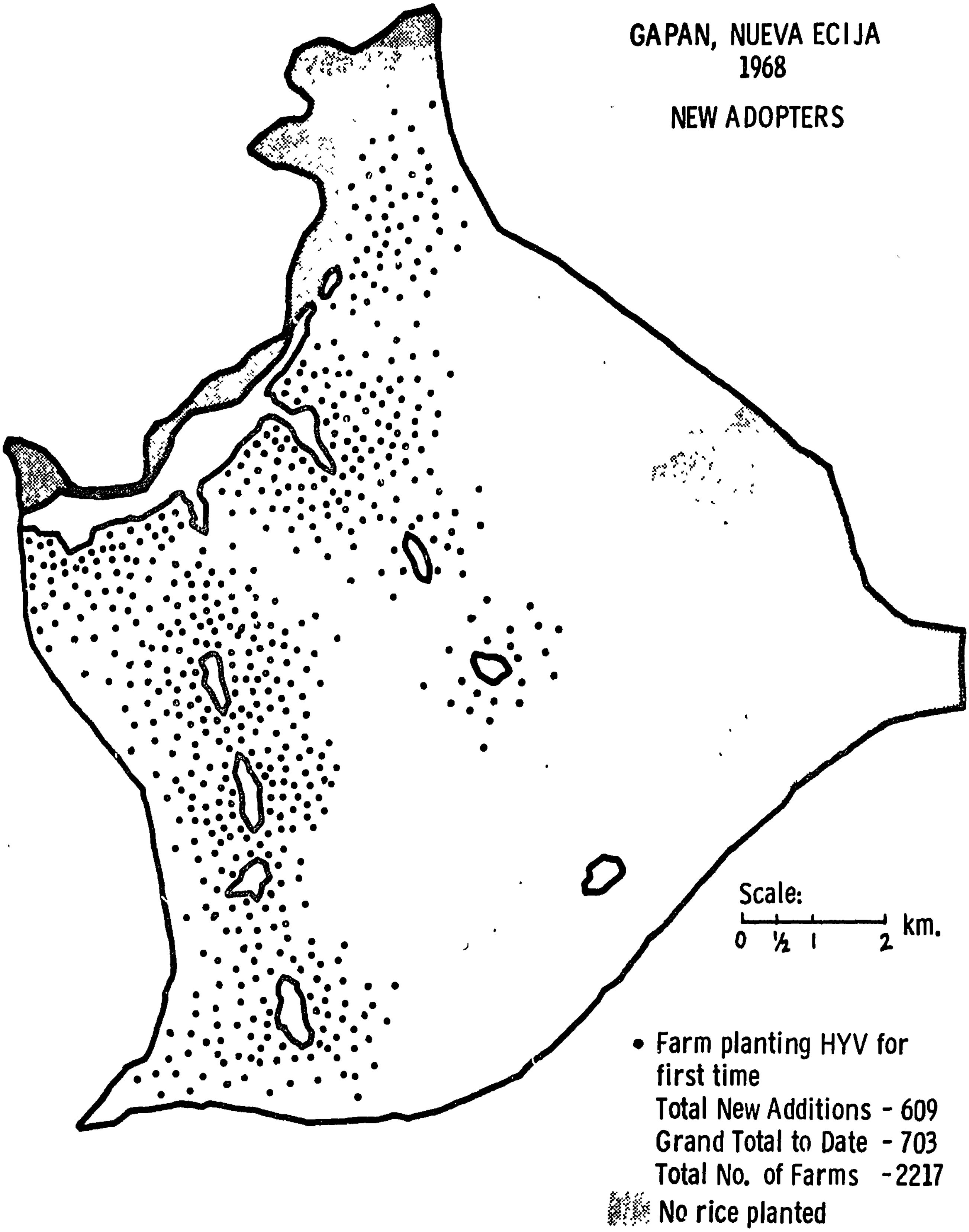
[2] Total number of farmers does not equal that shown on Table 2 because many farmers have both irrigated and non-irrigated land and are thus, counted twice in this table.

three barrios, less than 33 percent of the total land is irrigated while for the remainder of the municipality the figure is 95 percent. The conversion from traditional to HYV of rice involves far more than the use of new seed. Considerable investment in a variety of agricultural chemicals and more costly methods of cultivation are required if improved yields are to be achieved. Such investments involve very great risks on farms dependent for their water supply on rainfall alone, while on irrigated land a high rate of return on investment is relatively certain. At least early in the process of diffusion, farmers with little ready cash and inadequate credit facilities apparently hesitate to make the investment in HYV unless they have an assured water supply.

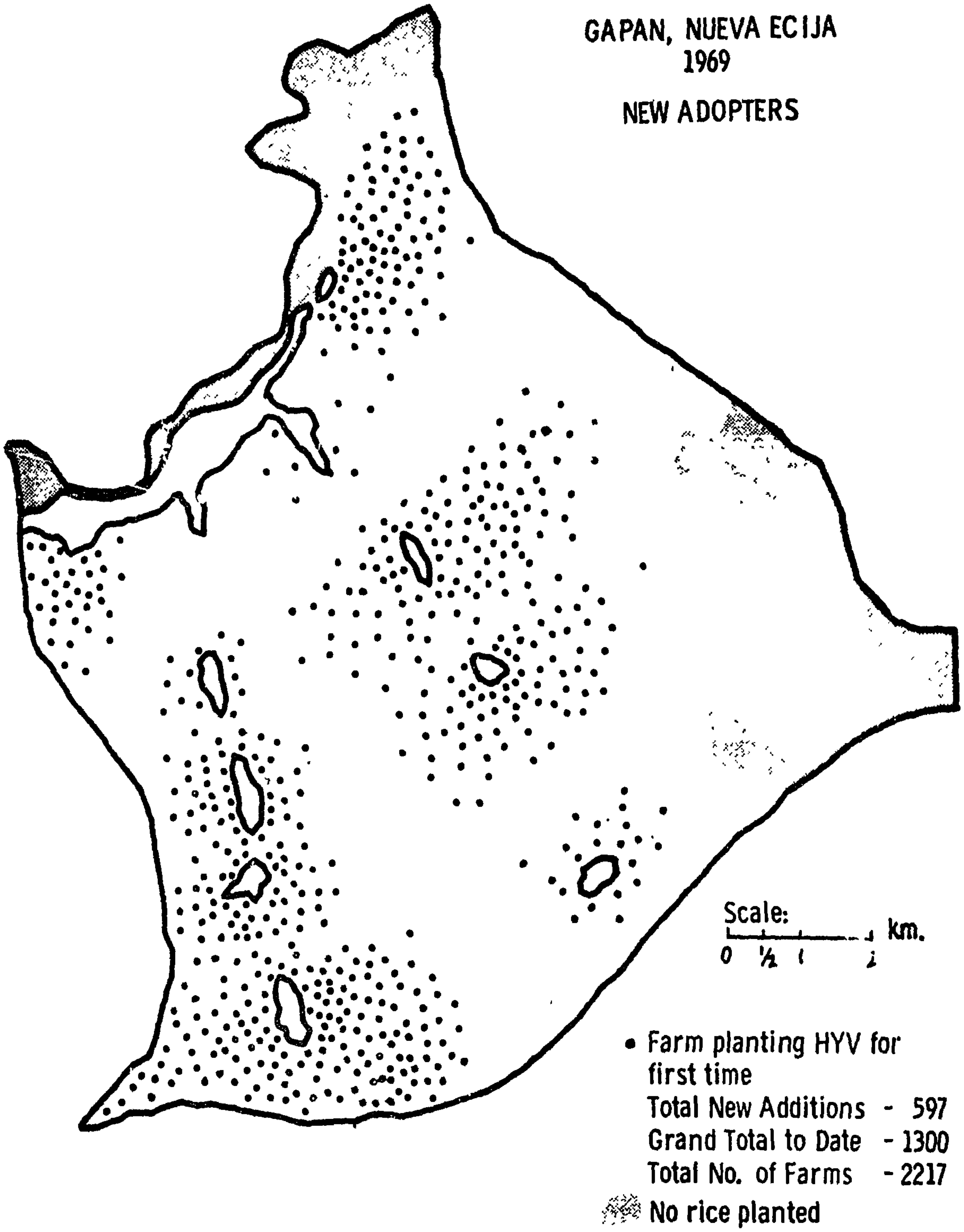
In 1969, the pattern of new adopters as shown on Map 5 was strikingly different from that of previous years. In 1969, the barrios of Mangino, Santo Cristo Norte, Santo Cristo Sur, and San Nicolas, the barrios having easiest contact with the poblacion, all showed a decrease in the number of new innovators while Santa Cruz, Kapalangan, Pambuan, Malimba, Baluarte and even Mahipon showed striking increases. The new adopters for this year were concentrated markedly in the barrios more remote from the center. The total new additions in 1969 numbered 597 or another 25 percent of the entire farm base. This map suggests a marked renewal of the outward spread of innovation from the original centers.

In large part the decrease in numbers of new adopters near the center is explained by reference to Table 2. By the completion of palagad planting in 1969, Mangino and San Nicolas already had 98 percent of their farms planted, at least in part, to HYV. With the exception of a few laggard farmers, everyone else had already converted. In the more remote barrios served by irrigation, adoption in 1969 reached the levels reached a year earlier in the more central location. However, in 1969 the proportion for farmers using HYV in barrios not well serviced by irrigation remained far below that in the more favored environmental situations. For example, Mahipon, both most remote and least favored with irrigation, had achieved only 11 percent conversion while in the remainder of the municipality 66 percent of the farmers were planting HYV.

The maps of innovation suggest four stages in the spatial pattern: (1) a concentrated focus of early adoption; (2) a dramatic outward extension from this center; (3) a marked elaboration of the pattern set in stage two and; (4) a renewed outward extension. To illustrate this changing pattern and to facilitate its quantification, a series of distance based graphs have been drawn and first time adopters plotted year by year. On these graphs all spatial relationships other than closest road distance from the center of innovation have been disregarded. Each barrio is represented by two circles, one-half kilometer apart. One-half kilometer is the mean road distance through the center of settlement and the circles are spaced at the actual measured road distance from the original center of innovation to the respective barrios. Farmsteads of new adopters are placed at random within the appropriate rings.


GAPAN, NUEVA ECIJA
1968
NEW ADOPTERS
Scale:
0 ½ 1 2 km.
● Farm planting HYV for first time
Total New Additions - 609
Grand Total to Date - 703
Total No. of Farms -2217
▨ No rice planted

Map No. 4


GAPAN, NUEVA ECIJA
1969
NEW ADOPTERS
Scale:
km.
0 ½ 1 2
• Farm planting HYV for first time
Total New Additions - 597
Grand Total to Date - 1300
Total No. of Farms - 2217
▨ No rice planted

Map No. 5

TABLE 2. Farms planting HYV, Gapan.[1/]

Barrio	1966		1967		1968		1969		Total number of farmers in barrio
	No. of farmers	% of innov.	No. of farmers	% of innov.	No. of farmers	% of innov.	No. of farmers	% of innov.	
Sto. Cristo N.	4	2.1	21	10.8	145	74.4	158	81.0	195
Sto. Cristo S.	1	0.7	11	7.3	82	54.3	126	83.4	151
Malimba	0	0.0	4	4.7	30	35.3	85	100.0	85
Baluarte	0	0.0	21	5.5	104	27.2	259	67.8	382
Kapalangan	0	0.0	0	0.0	22	9.4	97	41.3	235
Mangino	6	3.5	16	9.2	161	93.1	169	97.7	173
Pambuan	0	0.0	5	2.1	64	26.9	151	63.4	238
Mahipon	0	0.0	1	0.5	1	0.5	22	11.4	193
San Nicolas	3	2.9	10	9.5	70	66.7	103	98.1	105
Sta. Cruz	2	0.4	5	1.1	24	5.2	130	28.3	460
Total	16	0.7	94	4.2	703	31.7	1300	58.6	2217

[1/] Source: Revised by field checking of data gathered from the records of the Land Reform Office, Gapan.

The center of innovation is defined as the mean location of the home sites and the fields planted to IR8 by the 1966 innovators. Interviews with the 1966 adopters indicated that many interested neighbors both observed the "miracle rice" in the field and visited with the planter at his home to learn all they could about costs and methods of cultivation. Observation in the field and discussion at home were considered of equal weight in influencing the decisions of those who followed one year later. After plotting homes and fields of these first sixteen, the center of innovation was found by the simple techniques of superimposing a grid on the map, assigning each location the appropriate X and Y values and finding the mean on each axis. The resulting "center of innovation" as shown on Map 2, is located at an appropriate and logical site. It is adjacent to the municipality's only high school, where one of the original demonstrations plots was located, and adjacent to the Peñaranda Irrigation System administration office. The center is just a few meters east of the national highway immediately south of the poblacion.

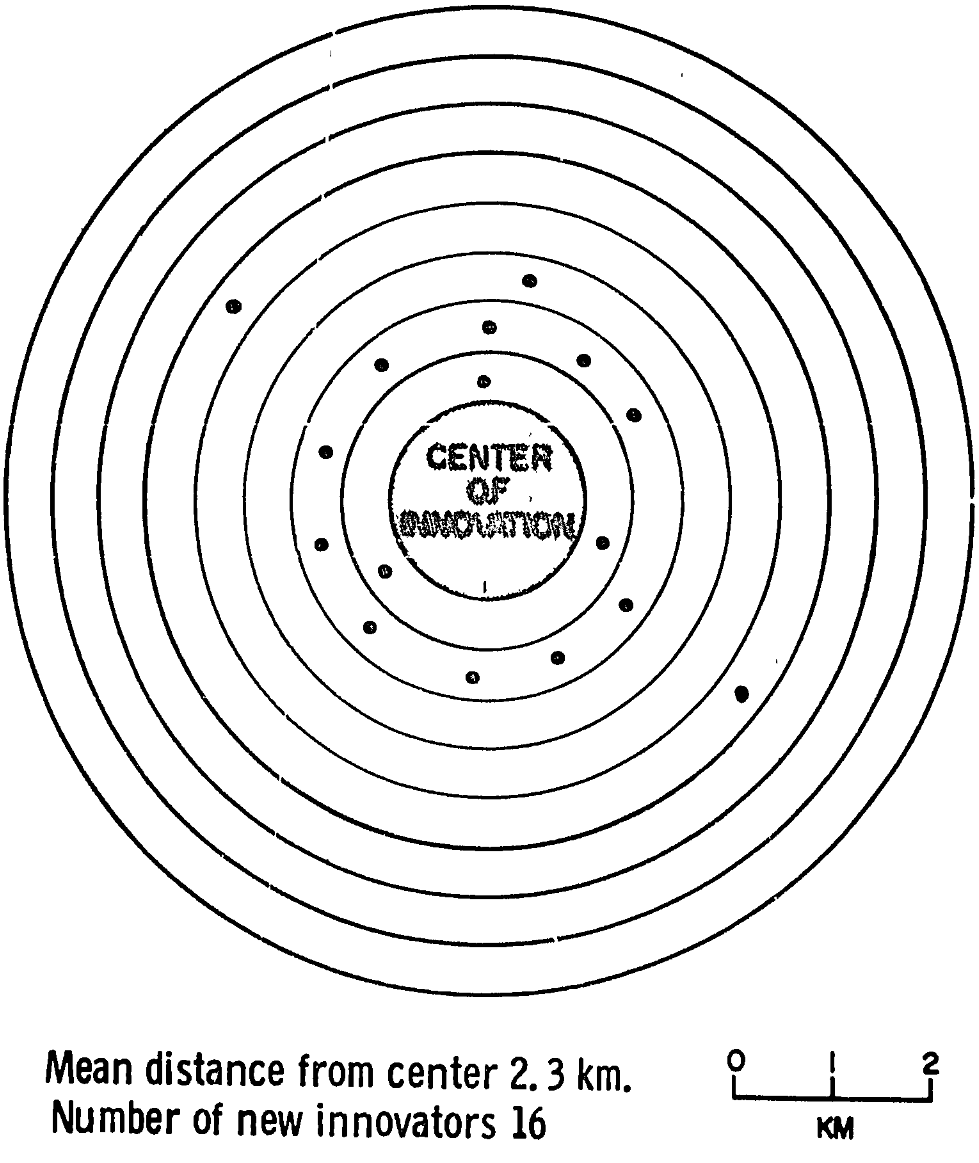
The graph for 1966, Figure 1, shows clearly the focus of innovation in the barrios closest to the center. Of the 16 farmers who planted IR8 in that season, thirteen were located within 2 km of the center and the most remote were only 4.5 km away. The mean distance from the center was 2.3 km. Figure 2 and Table 3 show the situation in the 1967 palagad season. A marked outward movement had taken place with even the most remote barrio having one farmers who raised HYV. The mean distance from the center in 1967 was 3.8 km.

The situation one year later is shown in Figure 3. The number of new adopters was eight times the number in 1967 and the pattern was striking. All barrios save Mahipon, the most remote, showed marked increases in numbers of farmers planting HYV but the most marked increases took place in those barrios having a two-year history of trial. The mean distance from the center decreased slightly to 3.3 km. Those barrios closest to the "center of innovation" showed the greatest increases while those more remote generally lagged behind. The year 1968 clearly was a year of "elaboration," a year during which the pattern established earlier was intensified.

By 1969, the "rings of innovation", Figure 4, had begun to spread out once more. The greatest concentration was no longer in the barrios closest to the center but in those at intermediate distances. The core area of Figure 4 representing barrios adjacent to the "center of innovation" is not heavily populated. The pattern is reminiscent of the spread of waves when a stone is dropped into calm water. By 1969 the hollow center was clear. In that year the mean distance from the center was 5.1 km.

The year by year changes in the mean distance to all new adopters from the center was striking. A comparison among means test was run on these data and the results indicate that the increase in distance from 1966 to 1967 and the renewed increases from 1968 to 1969 are significant at the 1 percent level while the 1967-68 change is barely significant at the 5 percent level. These results are shown in Table 4.

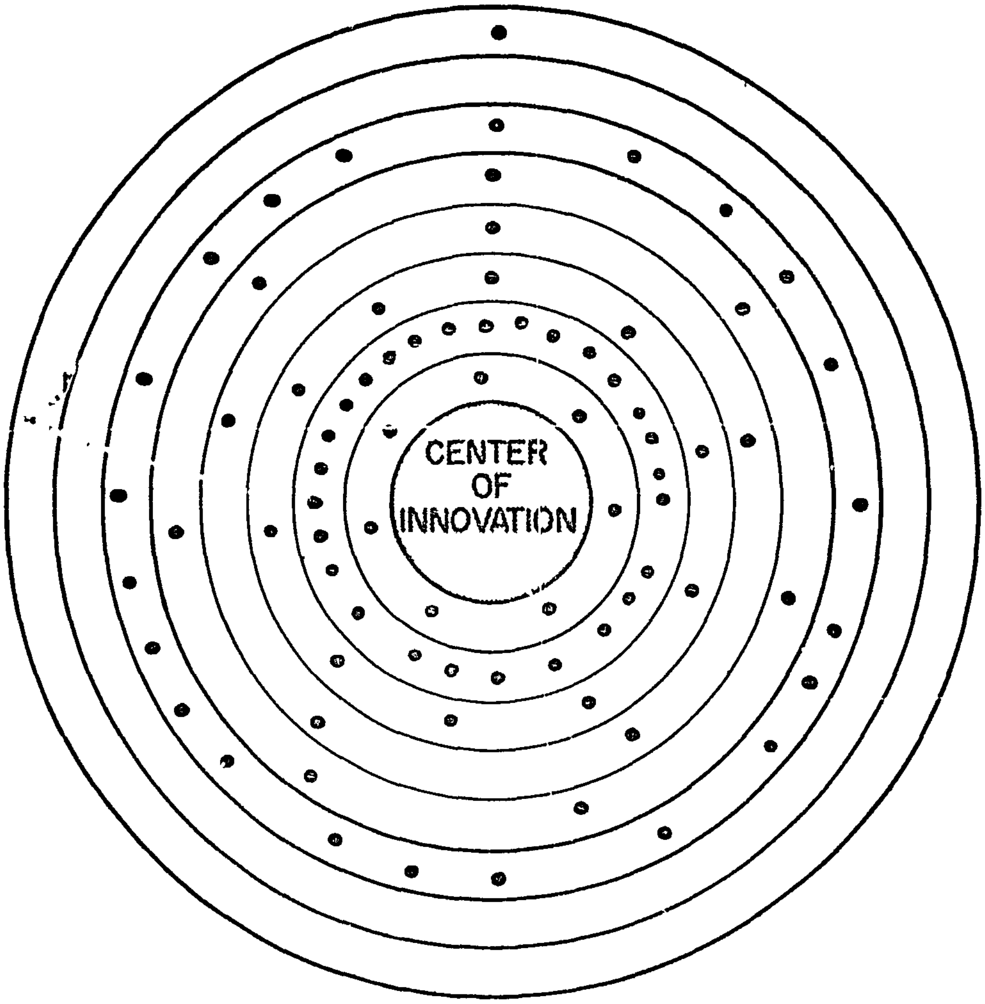
NEW INNOVATORS 1966
Gapan, Nueva Ecija



Mean distance from center 2.3 km.
Number of new innovators 16

Figure 1

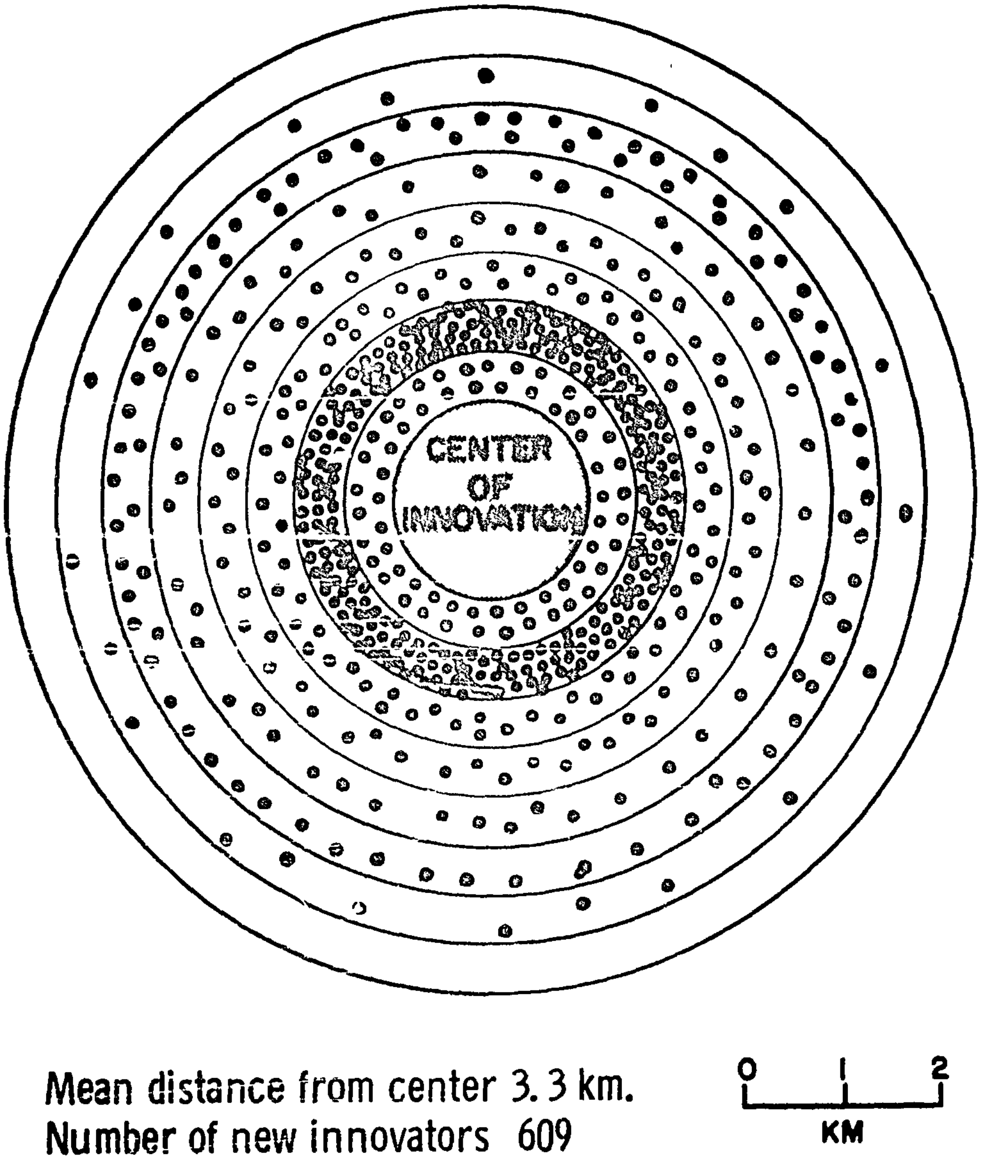
NEW INNOVATORS 1967
Gapan, Nueva Ecija



Mean distance from center 3. 8 km.
Number of new innovators 78

Figure 2

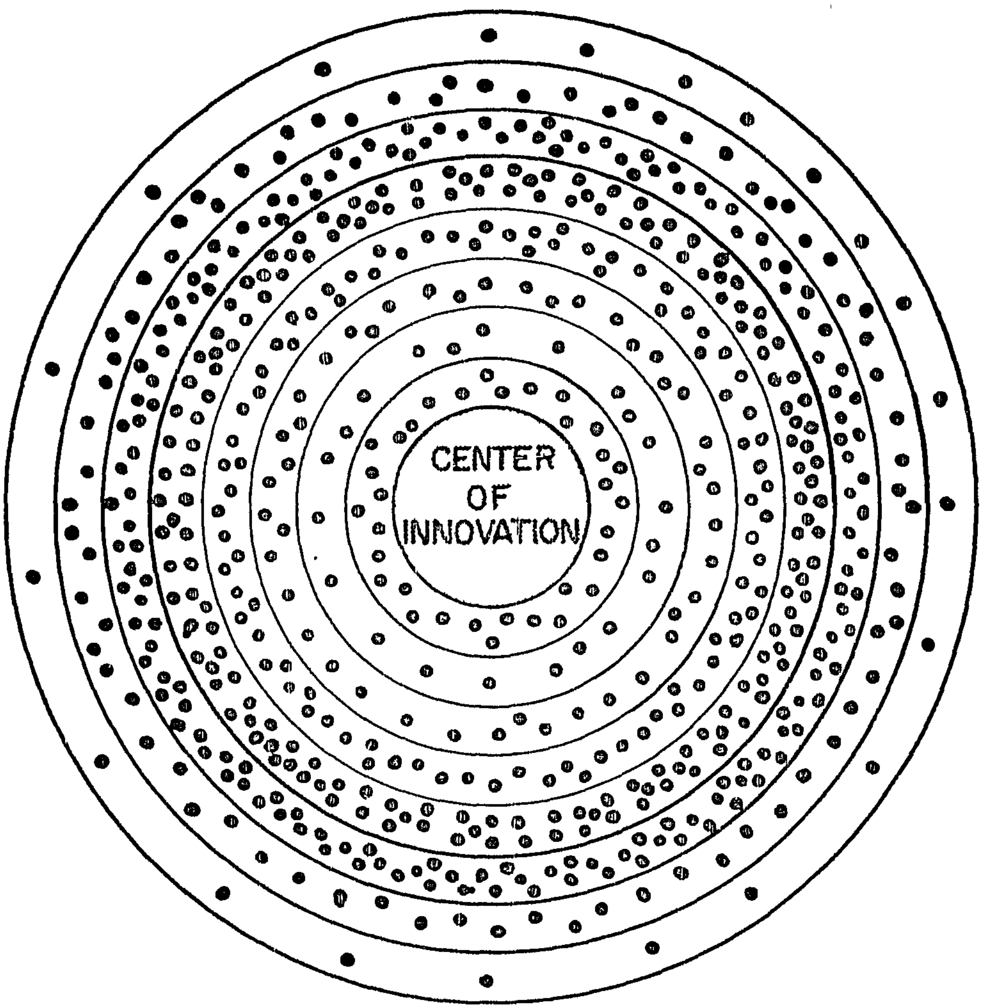
NEW INNOVATORS 1968
Gapan Nueva Ecija



Mean distance from center 3.3 km.
Number of new innovators 609

Figure 3

NEW INNOVATORS 1969
Gapan, Nueva Ecija



Mean distance from center 5.1 km.
Number of new innovators 597

Figure 4

TABLE 3. Number of new adoptions, Gapan.

Barrio	1966	1967	1968	1969
Sto. Cristo N.	4	17	124	13
Sto. Cristo S.	1	10	71	44
Malimba	0	4	26	55
Baluarte	0	41	83	155
Kapalangan	0	0	22	75
Mangino	6	10	145	8
Pambuan	0	5	59	87
Mahipon	0	1	0	21
San Nicolas	3	7	60	33
Sta. Cruz	2	3	19	106
Yearly total	16	78	609	597
Grand total to date	16	94	703	1300

TABLE 4. Mean distance and test of significance.

Mean Distance

Center to all NEW innovators

1966 - 2.3 kilometers
1967 - 3.8 kilometers
1968 - 3.3 kilometers
1969 - 5.1 kilometers

Comparison Among Means

	1966	1967	1968
1967	**		
1968	**	*/	
1969	**	**	**

** Significantly different at 1% level

*/ barely significant at 5% level

Figures 5 through 14 show the rate of adoption of HYV for each of the barrios in Gapan. These graphs, although they are based on only 4 years of observation, suggest a curve approximating an "S" shape. In settlements such as San Nicolas, Santo Cristo Norte and Mangino where there was a high percentage of farmers planting HYV in 1969, the "S" shape is clearly evident and the curve flattens out at a very high level of adoption. In barrios such as Baluarte, Pambuan and Santa Cruz, there were no innovators in 1966 and the development of the "S" curve is not yet evident. Here the entire process of adoption lags by a full year. In Kapalangan and Mahipon, the cycle is two years behind.

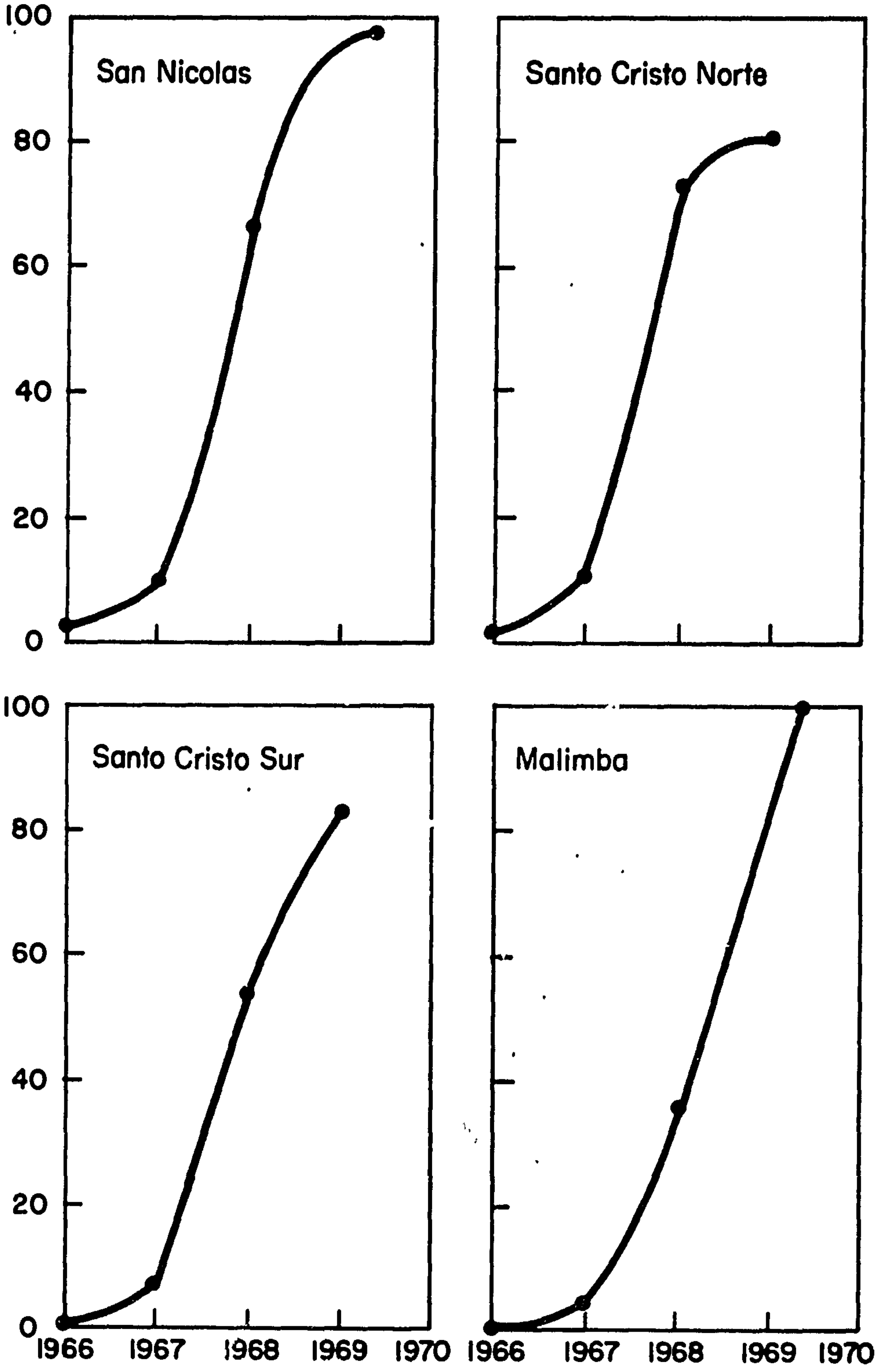
Figure 15 shows the percentage of farmers using HYV year by year for the municipality as a whole. This graph suggests that in Gapan, adoption was highly restricted at first, increased modestly the second year, jumped dramatically the third year, and increased somewhat less the fourth year. This curve suggests that the rate of increase for the municipality as a whole from 1969 to 1970 will be less than that achieved in either of the two preceding years. Because of the different stages of adoption at the various barrios, the curve for the municipal total is less dramatically "S" shape than in the curve for many of the individual barrios.

In view of the variation from barrio to barrio in the date of first adoption and in the stage of adoption achieved by 1969, a mean curve of adoption was developed as a possible method of more realistically indicating the potential percentage of adoption in Gapan as a whole. This graph (seeFig. 16) was developed by disregarding the date and moving all barrio graphs to the left sufficiently to allow the first year of actual planting of HYV to be plotted at the Y axis. The resulting curve is the adjusted mean of the 10 barrio curves. Data for this graph is shown in Table 5.

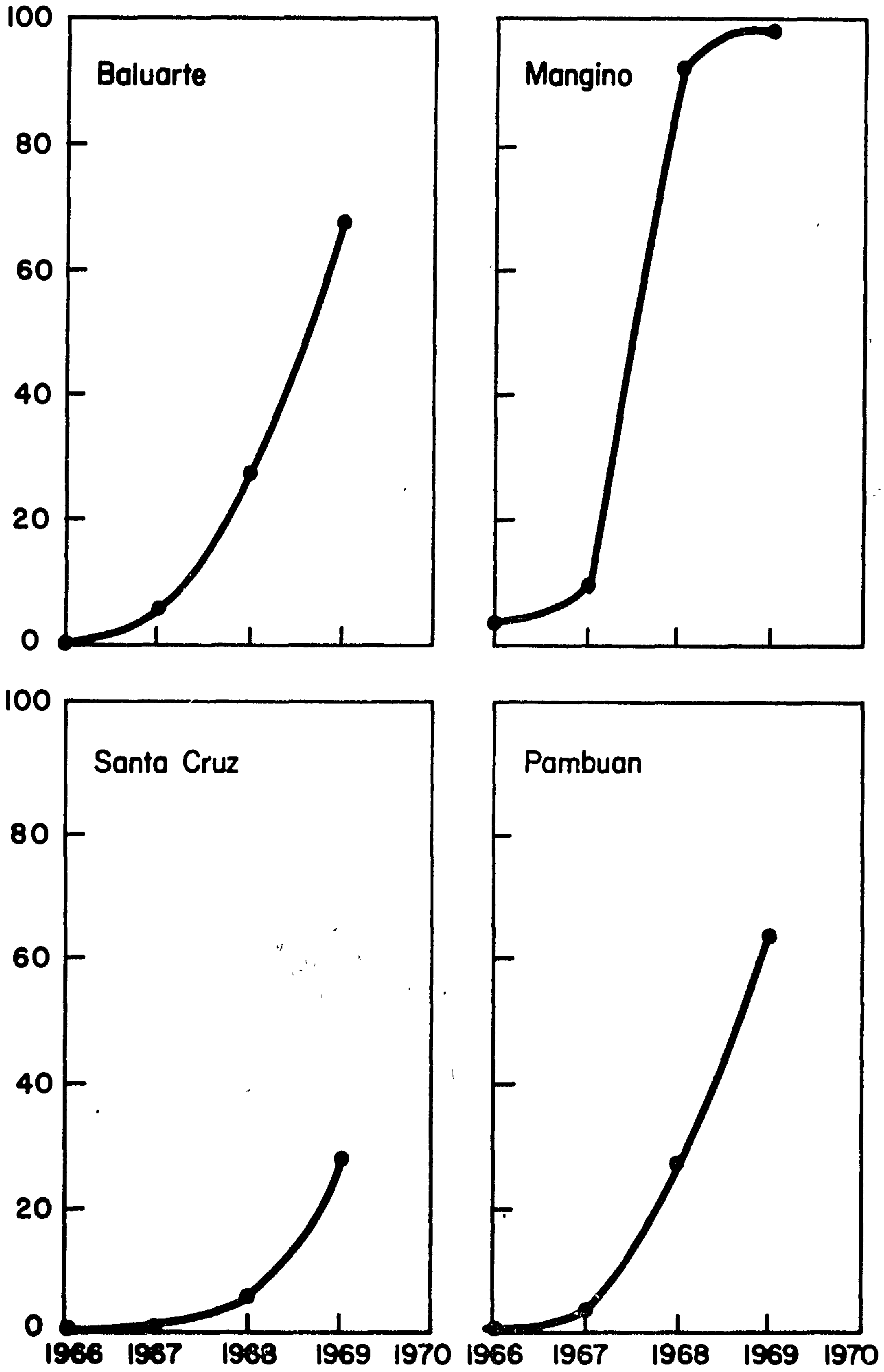
Discussions with a number of farmers and with several of the major landowners in Gapan indicated that most were pleased by the results achieved with the HYV and that they expected to continue using the new varieties. A number of farmers who had not yet planted the improved varieties indicated an intention to plant them during the coming year. In view of these observations and in view of the confidence in HYV shown by the farmers of San Nicolas and Mangino as indicated by Figures 5 and 10, there is reason to expect that in the years immediately ahead, the mean curve of adoption will continue to show an upward trend. That the curve could turn downward to assume a bell shape is a distinct statistical possibility but such an occurrence would be completely contrary to the present intentions of both owners and operators of the land.

4.0 SPATIAL FACTORS INFLUENCING THE SPREAD

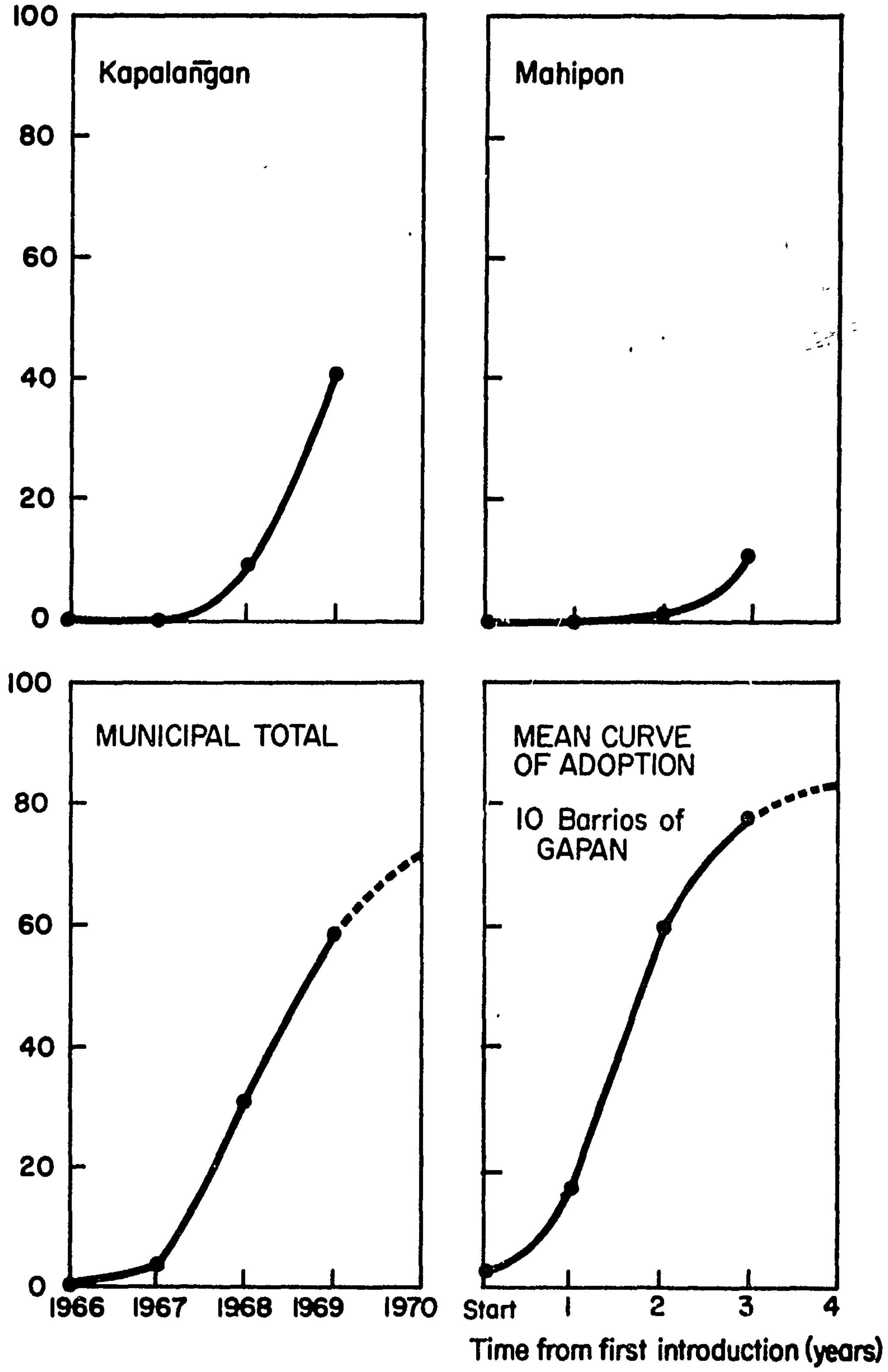
In an attempt to measure the relative importance of each of a number of spatially variable patterns on influencing the spread of HYV in Gapan, a correlation matrix was developed and stepwise regression formulas were determined for each year. Six variables were considered:


San Nicolas
Santo Cristo Norte
Santo Cristo Sur
Malimba
100
80
60
40
20
0
100
80
60
40
20
0
1966
1967
1968
1969
1970
1966
1967
1968
1969
1970

Figures 5 - 8


Baluarte
Mangino
Santa Cruz
Pambuan
100
80
60
40
20
0
1966
1967
1968
1969
1970

Figures 9 - 12



Figures 13 - 16

TABLE 5. Data for mean curve of adoption.

Barrio	% for farmers who use HYV			
	Start	1 year later	2 years later	3 years later
Sto. Cristo N.[1]	2.1	10.8	74.4	81.0
Sto. Cristo S.	0.7	7.3	54.3	83.4
Malimba	4.7	35.3	100	-
Baluarte	5.5	27.2	67.8	-
Kapalanga	9.4	41.3	-	-
Mangino	3.5	9.2	93.1	97.7
Pambuan	2.1	26.9	63.4	-
Mahipon	0.5	0.5	11.4	-
San Nicolas	2.9	9.5	66.7	98.1
Sta. Cruz	0.4	1.1	5.2	28.3
Mean	3.2	16.9	59.6	77.7

[1] Underlined data refer to the 1969 situations in each *barrio* - shown also in the first data column of Table 6.

X_1 percentage of land irrigated by *barrio*,

X_2 number of original innovators in 1966 by *barrio*,

X_3 cost of transportation of fertilizer from the source in the *poblacion* to each *barrio*,

X_4 the settlement pattern, mapped as continuous or non-continuous,

X_5 the percentage of owner-operators by *barrio*, and

X_6 the percentage of leaseholders by *barrio*.

The cost of transportation of fertilizer was considered as possibly of importance because the success of HYV depends to a considerable degree in the application of nitrogen. Interviews with extension workers, with fertilizer sales persons and with farmers themselves suggested that the cost of transportation might be a limiting factor. Owners of farm land who help purchase fertilizer for their tenants often require that the tenant using the chemicals cover the cost of delivery to the farm as well as the cost of application. Owner-operators and leasehold operators can sometimes get loans to cover the cost of fertilizer but not for its transportation. Even though, this transporation averages only about two percent of the cost of the fertilizer, it is more than many small farmers are willing to pay.

Perhaps in response to this consideration as well as to the rapidly increasing competition in the sale of fertilizers, all fertilizer sales outlets in Gapan began free delivery to the farm as of the 1969 *palagad* season. If the cost of transportation had an impact on the spread of HYV in the early years that influence presumably disappeared in 1969.

The settlement pattern was classified continuous or non-continuous by the application of a technique of measuring the mean distance between cultivation centers first used by Sidenbladh in 1880.[8]

The formula: $d = 1.1 \quad A/N$

where:

d = the distance of a circle drawn around each center

A = the areas of all cultivated land

N = the number of settlements

8/ See: Torsten Hagerstrand. *Innovation Diffusion as a Spatial Process.* University of Chicago Press, Chicago, 1967, pp. 39-42.

was applied to Gapan. Circles were drawn around all barrios and those for San Nicolas, Mangino, Santo Cristo Norte, Santo Cristo Sur and Malimba intersected, indicating continuous settlement and suggesting that here the "neighbor effect" might be strongest.

The correlation matrix indicates that while the factor of continuous settlement was not significant in the case of the original innovators of 1966 it was highly significant during each of the years of the spread. For 1967, 1968, and 1969 the coefficient of correlation indicates significance at the 1% level. Apparently, the "neighbor effect" has in fact been important in Gapan.

In Gapan, seventy-two percent of the farm land is irrigated while the remaining twenty-eight percent is rainfed. Earlier studies of the spread of HYV indicate that the availability of irrigation is of considerable importance in the adoption of these varieties. In areas without irrigation water, the extra investment in fertilizers, pesticides and herbicides is often wasted if rainfall is inadequate or poorly timed.[9/] By contrast, area with adequate irrigation water are more likely to show greater consistency in increased yields and profitability. Thus, logic dictates that farms with irrigation available would adopt HYV sooner and over a larger percent of the area than would farms with no irrigation.

This logic is substantiated by the coefficients of correlation. As shown in Table 7, the percentage of irrigation and percentage of adoption were positively related at a 1 percent level of significance in both 1967 and 1969 and at a 5 percent level in 1968.

Theory of the diffusion and adoption of innovation[10/] emphasizes the point that acceptance of an innovation by one farmer acts to stimulate acceptance by others. Central place theory tells us that such stimulus should act most strongly on the immediate neighbors of the original innovator and that the strength of the stimulus should decrease as distance increases. If this interaction effect is correct than the location of the sixteen original planters of IR8 in Gapan should have had considerable impact on the development of the present spatial pattern of HYV in the community.

Statistical evidence indicates that in fact such has been the case. The coefficients of correlation between the locations of original innovators and the patterns of adoption for both 1967 and 1968 indicate significance at the 1 percent level. However, by 1969 the adoption had spread so widely that it no longer showed a significant relationship to the 1966 pattern.

[9/] See for example: The International Rice Research Institute, Annual Report 1968, Agricultural Economics, Los Baños, Philippines.

[10/] See: Everett M. Rogers. Diffusion of Innovations. The Free Press, New York, 1962. Chapter XI.

TABLE 6. Percent of farms and percent of area with HYV by barrio 1969, Gapan.

Barrio	% of farms with HYV	Total farm area (ha.)	Area in HYV (ha.)	% of area in HYV
Sto. Cristo N.	81.0	514	413	80.3
Sto. Cristo S.	83.4	421	328	77.9
Malimba	100	231	231	100
Baluarte	67.8	1291	864	66.9
Kapalangan	41.3	739	259	35.0
Mangino	97.7	479	466	97.2
Pambuan	63.4	648	415	64.0
Mahipon	11.4	693	33	4.7
San Nicolas	98.1	229	223	97.3
Sta. Cruz	28.3	1665	285	17.1
Total	58.6	6910	3517	50.9

TABLE 7. Correlation Matrix (n = 10)

	% Irrigation	No. Innov. '66	Continuous settlement	Cost trans	% land owner '69	% Lease hold '69
% Adopter '67	0.7650**	0.7198*	0.8454**	-0.7445*	0.0464$^{\text{n.s.}}$	-0.1698$^{\text{n.s.}}$
% Adopter '68	0.7343*	0.8171**	0.8496**	-0.8346**	-0.0632$^{\text{n.s.}}$	-0.0774$^{\text{n.s.}}$
% Adopter '69	0.9097**	0.4525$^{\text{n.s.}}$	0.8395**	-0.6581*	-0.0435$^{\text{n.s.}}$	-0.3707$^{\text{n.s.}}$
% Irrigation		0.3627$^{\text{n.s.}}$	0.6473*	-0.6343*	-0.2941$^{\text{n.s.}}$	-0.3343$^{\text{n.s.}}$
No. of Inn '66			0.5970$^{\text{n.s.}}$	-0.8217**	-0.0419$^{\text{n.s.}}$	-0.0786$^{\text{n.s.}}$
Continuous settlement				-0.6428*	0.2284$^{\text{n.s.}}$	-0.1562$^{\text{n.s.}}$
Cost trans					0.0547$^{\text{n.s.}}$	0.1318$^{\text{n.s.}}$
% Landowner						-0.3150$^{\text{n.s.}}$

** Significant at the 1% level.

* Significant at the 5% level.

$^{\text{n.s.}}$ not significant.

Social scientists have often said that low productivity of Asian farms and resistance to change is in large part due to the fact that many farmers are tenants rather than owner-operators. Because they are tenants lacking long term tenure agreements they can see little gain from improving the productivity of the land. One argument of those persons favoring immediate land reform has been that the farmer on leasehold is more highly motivated to increase production than is the tenant. Gapan provides a modest test for certain generalizations of this nature. Because it was one of the three earliest municipalities in the nation to be declared a land reform area, a good deal of effort has been expended to assure success of the program. At the start of the land reform program in August of 1964, more than 2,000 of the 2,300 farmers in Gapan were share tenants. By the beginning of 1969, this number had been reduced to 1,006 while the number of leasehold farmers had increased from 45 to 1,038. Thus, in the relatively short period from 1964 to 1968, a new class of farmers had been created in Gapan. These were presumably men who had not been completely satisfied with the traditional share tenancy system and who took advantage of the opportunities presented by Land Reform to improve their position. These farmers might be thought of as being the most progressive and dynamic in the municipality. Their distribution by barrio is indicated on Map 8. Clearly, the conversion had not been at a uniform rate from barrio to barrio. The farm population of Baluarte, San Nicolas and Malimba equals 20 percent of the municipal total and only 15 percent of these farmers are on leasehold, as is shown on Table 7; by contrast Santo Cristro Norte, Santo Cristo Sur and Mahipon also have 20 percent of the farm population and here 65 percent of the farmers are under leasehold.

To measure the possible relationship between the conversion to leasehold and the spread of HYV year by year, correlation coefficients were developed. These show a negative correlation of small magnitude for each of the 4 years. The coefficients, although consistently negative, prove to be not significant. These data suggest that, in Gapan at least, the process of adopting new rice varieties is not encouraged by the transformation from share tenancy to leasehold. In fact, the transformation may act to discourage adoption.

This pattern may be due to the fact that leasehold operators are seldom able to acquire loans for fertilizer, pesticides and other agricultural inputs from the Rural Banks and are almost never extended credit by their landlords who, because of fixed rental, no longer have anything to gain from improved yields. By contrast those farmers in land reform areas who have chosen to remain on a share tenancy arrangement are those working with progressive land owners. In such situations capital expenses for agricultural inputs are shared equally and credit is extended with little or no interest by the landlord. His profit comes from improved yields.

A stepwise multiple regression formula was computed for each year in order to more carefully measure the relative importance of each of the independent variables on the percentage of adopters. The results are as follows:

1967 Adopters (Y_1)

$$\hat{Y}_1 = -3.79387 + 0.04363^{*} X_1 \text{ (\% irrigation)} + 0.66263 X_2 \text{ (No. of innovators)} + 2.94550 X_4 \text{ (continuous settlement)}$$

$(R^2 = 0.87438)$

1968 Adopters (Y_2)

$$\hat{Y}_2 = -25.74563 + 0.29689^{*} X_1 \text{ (\% irrigation)} + 7.36544^{**} X_2 \text{ (No. of innovators)} + 20.14968 X_4 \text{ (continuous settlement)}$$

$(R^2 = .95534)$

1969 Adopters (Y_3)

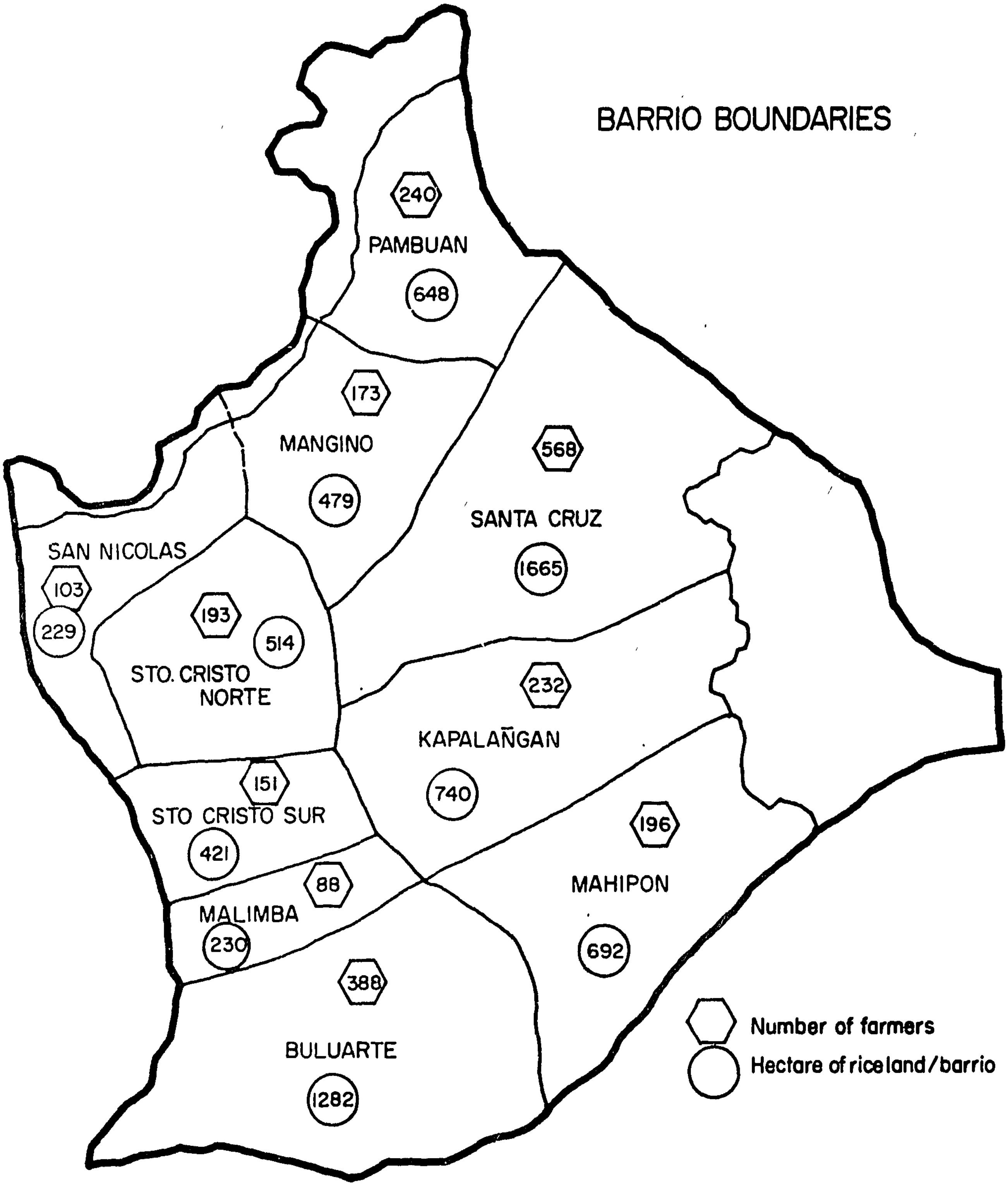
$$\hat{Y}_3 = -5.70832 + 0.51010^{**} X_1 \text{ (\% irrigation)} + 26.13651 {}^{*} X_4 \text{ (continuous settlement)} - 0.13445 X_4 \text{ (\% leasehold)}$$

$(R^2 = .94538)$

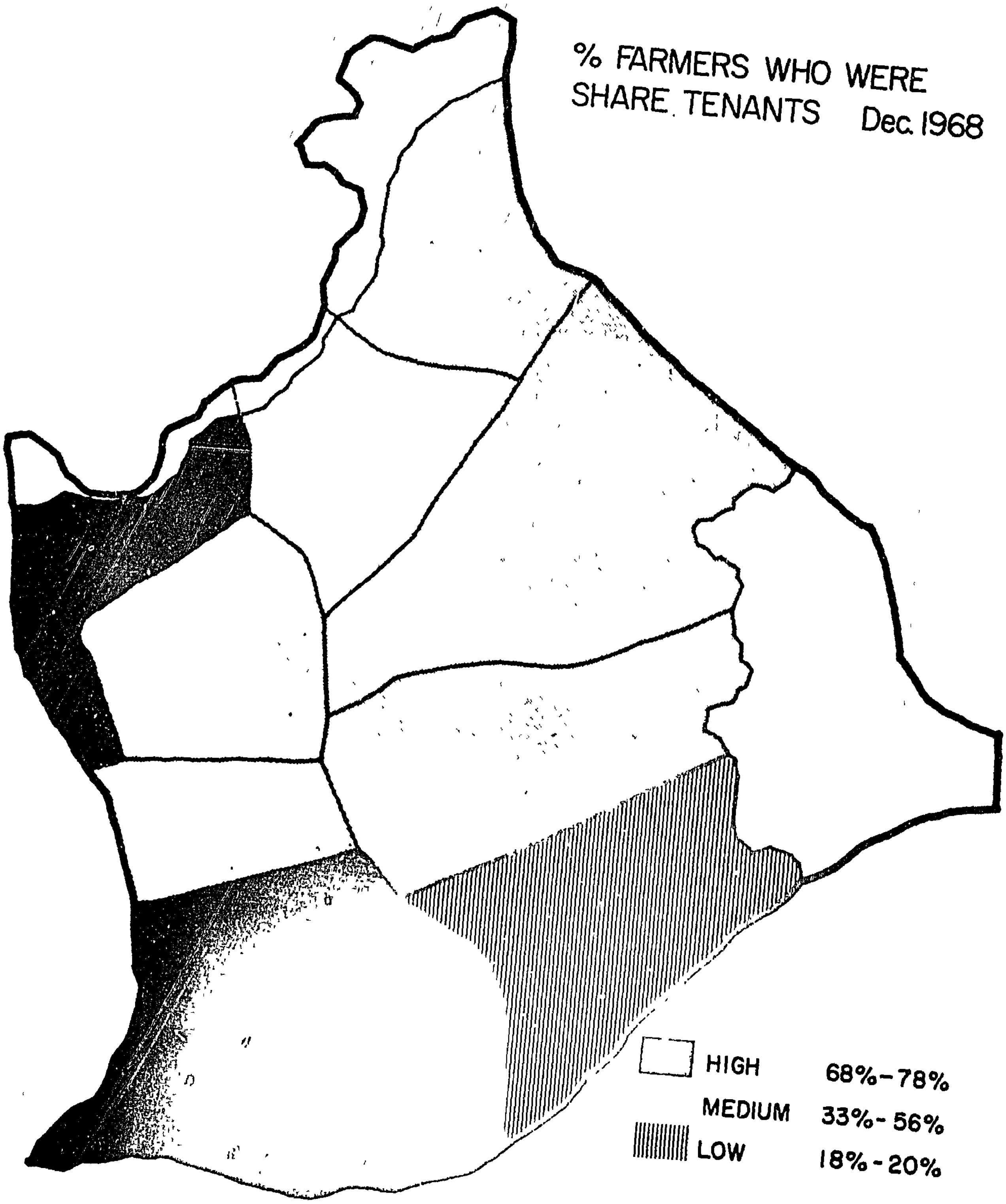
It will be noted that in each of the three formulas for estimating Y there are only three independent variables included. In the stepwise regression analysis the variable producing the greatest change in Y is included first, the next greatest second and so on. When the addition of the next most important variable in the equation fails to produce a significant change in Y it is excluded and the formula is considered complete. This does not mean that such excluded variables are not important but only that their influence is also measured by the included variables. It may be judged that in this case the independent variables are themselves strongly interrelated.

The three stepwise multiple regression equations each include the factor "percentage of irrigation" as the most important single variable. The correlation matrix by contrast shows that "continuous settlement" is more closely related to percent adopter in 1967 and 1968 than is "percent irrigation." However, when the latter was brought into the regression equation the contribution of "continuous settlement" was reduced, suggesting an interdependence between the two.

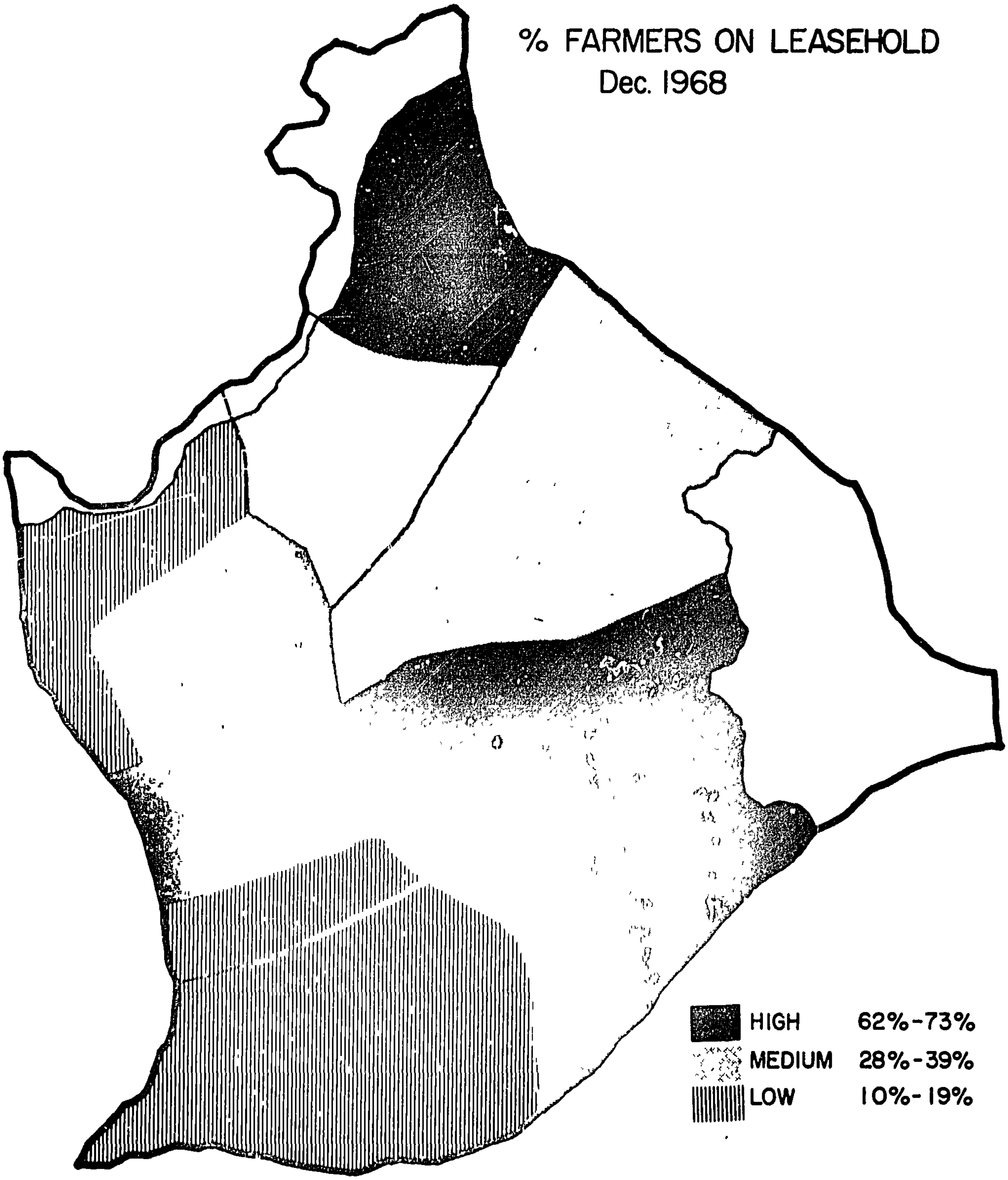
For the 3 years taken together, the most important factor explaining the variation of percentage of adopters is "percent irrigation." The second factor is "continuous settlement" which is also represented in each of the three equations. In the years 1967 and 1968 the location and number of original innovators had an apparently strong influence which had diminished significantly by 1969. In all 3 years the coefficient of determination (R^2) was of such a magnitude as to indicate a high degree of confidence in the formula.


BARRIO BOUNDARIES
240
PAMBUAN
648
173
MANGINO
479
568
SANTA CRUZ
1665
SAN NICOLAS
103
229
193
514
STO. CRISTO NORTE
232
KAPALAÑGAN
740
151
STO CRISTO SUR
421
196
MAHIPON
692
88
MALIMBA
230
388
BULUARTE
1282
Number of farmers
Hectare of riceland/barrio

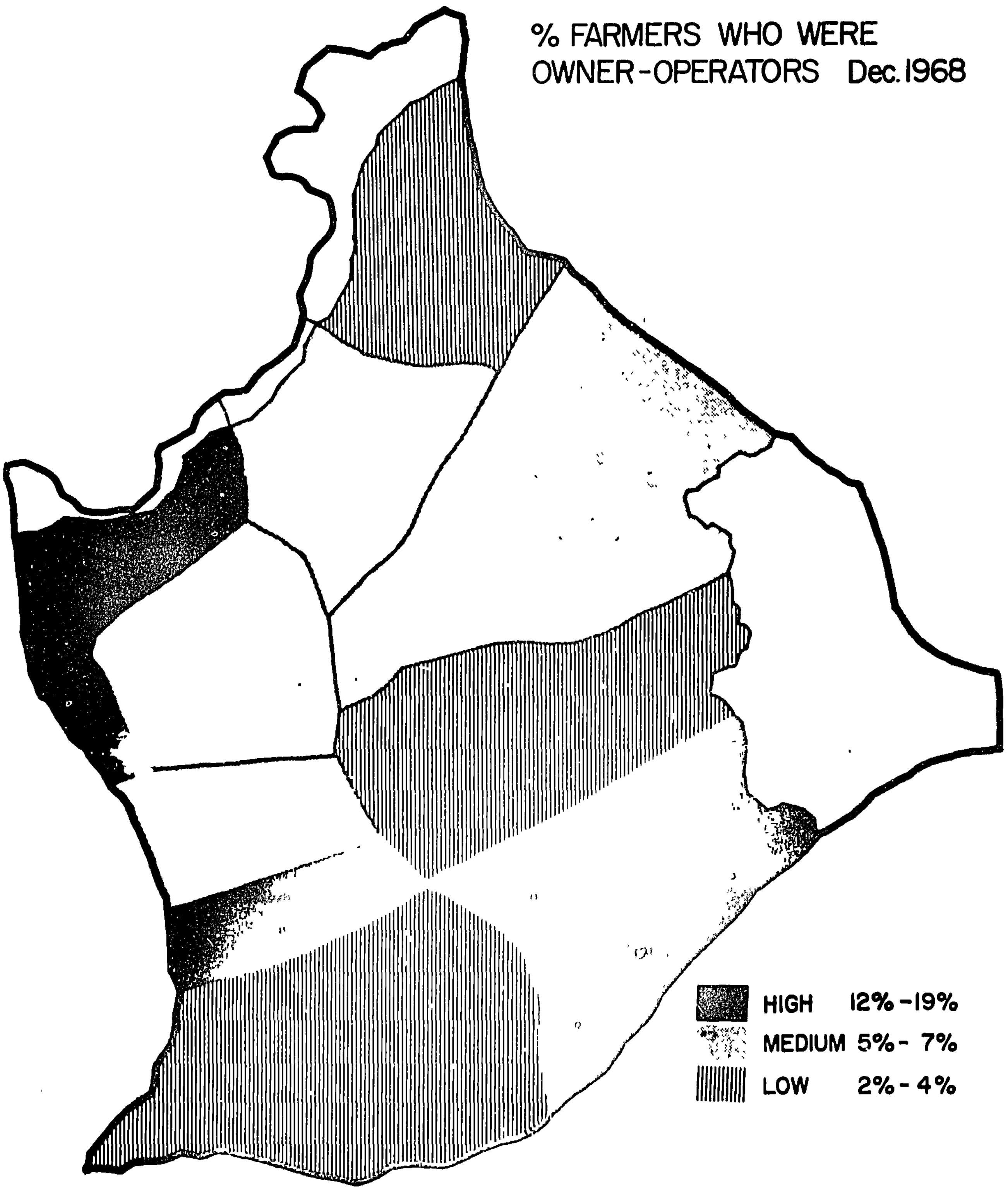
Map No. 6


% FARMERS WHO WERE
SHARE TENANTS Dec. 1968
☐ HIGH 68%-78%
MEDIUM 33%-56%
▥ LOW 18%-20%

Map No. 7


% FARMERS ON LEASEHOLD
Dec. 1968
HIGH 62%-73%
MEDIUM 28%-39%
LOW 10%-19%

Map No. 8



% FARMERS WHO WERE OWNER-OPERATORS Dec. 1968

Map No. 9

TABLE 8. Tenure status and adoption, December 1968, Gapan.[1/]

Barrio	Owner-operators		Share-tenants		Leasehold		% of each group which had adopted		
	Number	%	Number	%	Number	%	Owners	Share	Leasehold
Sto. Cristo N.	10	5	64	33	121	62	30	69	77
Sto. Cristo S.	10	7	30	20	111	73	70	90	90
Malimba	10	12	66	78	9	10	75	33	33
Baluarte	17	4	293	77	56	19	31	27	22
Kapalangan	9	4	80	34	146	62	?	?	?
Mangino	8	5	97	56	68	39	62	75	82
Pambuan	5	2	85	36	146	62	?	?	?
Mahipon	35	18	35	18	132	64	3	0	0
San Nicolas	20	19	72	68	13	13	60	58	69
Sta. Cruz	32	7	185	40	243	28	19	6	30
Total	158		1007		1038				

[1/] Source: Land Reform Office, Gapan, N. E. (Note: The date of this table is December 1968 while the population shown in table 2 refers to mid-1969. Differences in the population totals shown on the two tables are due to the fact that several minor tenure categories such as cash and share; rent fee; fixed produce; and other (together including 16 farmers) are omitted from this table).

Of the various spatial factors analyzed with respect to the diffusion of high yielding varieties in Gapan, most of those found to be significant appear to play a role in determining the direction and speed of movement of adoption. Clearly, this is true of the location of original innovators, the settlement pattern and the cost of transportation. The irrigation factor, however, appears to be somewhat different in that it is the most important single factor and that it appears to place an upper limit on the degree of adoption.

Three barrios which are serviced over their entire area by irrigation appear to have completed the cycle of adoption. These three, Mangino, Malimba and San Nicolas have achieved an average of 98 percent adoption of high yielding varieties. Two other barrios also completely irrigated have not yet completed the cycle. These barrios, Santo Cristo Norte and Santo Cristo Sur, have already reached an adoption rate of 82 percent. They appear to be headed toward a levelling off somewhere in the low 90's. Observed data from these five barrios suggests that for irrigated land the expected potential conversion level is approximately 95 percent.

In Santa Cruz, Kapalangan and Mahipon, where major portions of the rice land are rainfed, the adoption curves lag well behind those of irrigated barrios. In the rainfed areas a number of farmers express little interest in making the relatively heavy investments of labor and capital necessary for success with the HYV. The risks involved on rainfed land are far greater than on irrigated land.

In view of the strong evidence illustrating the importance of irrigation in the conversion from traditional to high yielding varieties it seems reasonable to expect the conversion rate for rainfed areas level off at only about half the rate of irrigated areas.

Seventy-two percent of Gapan's rice area is irrigated while 28 percent is rainfed. Ninety-five percent of the irrigated land plus 47-1/2% of the rainfed land totals 81.7 percent of Gapan's rice area. This figure might be considered as a rough estimate of Gapan's potential for conversion to high yielding varieties.

The graphed labeled "Municipal Total" showing the percentage of adoption for Gapan as a whole indicates that in 1969 slightly less than 60 percent of the rice farms had been converted at least in part to high yielding varieties. It should be emphasized that this graph shows the actual summation of data for 10 barrios of which only five began the cycle of adoption in 1968. Four barrios began the cycle in 1967 and one delayed until 1968.

The Mean Curve of Adoption takes this staggering of the starting date into account and thus may be a better forecasting device for the municipality as a whole. The Mean Curve of Adoption reaches the 60 percent level during the third year of the cycle (2 years after the initial planting of high yielding varieties in the barrio) and after that the rate of increase begins to slow perceptably. In the fourth year, the mean curve reaches 78 percent. No barrio has as yet had more than four years experience with high yielding varieties.

The Mean Curve of Adoption has the "S" shape of a typical logistic curve which may be described by the formula:

$$P = \frac{V}{1 + e^{(a-b.T)}}$$

were:

P = percentage of farmers adopting high yielding varieties

V = upper limit of adoption (in this case 95% of irrigated farms plus 47.5% of rainfed farms or 81.7 percent)

T = time in years (from graph)

e = constant with value 2.7183

a = parameter controlling the height of the curve at the start

b - parameter controlling the steepness of the curve

By substituting observed data from the Mean Curve of Adoption, values for a and b may be approximated by the least squares method. The resulting estimated regression equation is of the form:

$$P = \frac{81.7}{1 + 2.7183^{(3.2665 - 2.065T)}}$$

The curve produced by this equation is an excellent fit with the curve of observed values over the time period 0-3 years as is shown by the R^2 value of 0.998 indicated on Table 9. On the basis of this close fit, the estimated regression equation was used to project the curve forward. Such a projection gives an estimated value of P for year 5 of 81.5 percent. At year 5 the curve approaches the asymptotic position, thus the figure of 81.5 may be used as an estimate of the potential conversion rate. This result is remarkably close to the estimate of 81.7 percent suggested earlier as the upper limit of adoption for Gapan given the present resources.

It should be emphasized that this estimate assumes a constant physical base with no significant change in the capital investment for irrigation. It is entirely possible that increased productivity will lead to increasing land values and greater investment per hectare. In that case irrigation could reasonably be expected to expand with a concomitant increase in the upper limit of adoption.

TABLE 9. Actual and estimated P values.

Time (years after first adoption)	Observed P	Estimated P
0	3.2	3.0
1	16.9	18.9
2	59.6	57.7
3	77.7	77.8
4	-	81.5

$R^2 = 0.998$

5.0 CONCLUSIONS

The pattern of spread of high yielding varieties in Gapan owes much to the fact that three major landowners had sufficient political or economic power to secure IR8 seeds in July 1966. These three landlords caused the seed to be planted by selected tenants in barrios close to poblacion. From this modest beginning, the use of high yielding varieties spread unevenly but with great speed to all corners of the municipality.

The diffusion followed a pattern quite similar in many ways to patterns identified by a variety of authors working in the USA and Western Europe. A variety of factors including irrigation, the settlement pattern and the cost of transportation were found to have influenced the spread but the most striking feature was that in irrigated barrios with as little as 4 years of contact with high yielding varieties the cumulative percentage of adoption was over 80. For Gapan as a whole the figure was 59 percent at the end of 4 years. This rate of adoption exceeds the rate found by researchers dealing with similar innovations in the U.S.A. or Western Europe.[11]

While Gapan is atypical of Central Luzon in that it has a very high percent of its land under irrigation, it is quite representative in other respects. With the same extension efforts, there is no obvious reason why the rate of conversion to high yielding varieties for irrigated and for rainfed areas identified in Gapan should not be equally valid for other municipalities.

Gapan also provides some insights for planners and for the extension services. The acceptance of an innovation requiring increased capital outlay either in the form of cash or labor is most rapid and most successful where risks are minimized. In the case of rice farming the greatest risks appear to be related to the availability of adequate water. Thus, all possible efforts should be made to extend and to improve irrigation facilities. This should be a first order priority for government and private investment alike.

Ready availability of working capital is also a necessity, In the Philippines today much of the cash for agricultural inputs is provided by landlords. Until adequate substitute sources can be developed, these owners must be encouraged to continue their banking function.

Finally, the rapid spread of innovation owes much to the number of original adopters. Introduction of HYV seed spread among 16 non-contiguous farmers was far more effective in Gapan than would have been the case had the original seed been planted in a single block. Future innovations, too, are likely to be more strongly related to the number of introductions than to the scale of the individual operations.

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[11] For example, in the U.S.A., it took 8 years for hybrid seed corn to be adopted by 59 percent of group of Iowa farmers. See: Everett M. Rogers, op. cit., p. 141.

PRODUCTIVITY OF FARM USING TRADITIONAL AND IMPROVED RICE VARIETIES IN RIZAL AND LAGUNA

P. C. Manuel and M. P. Lopez [1/]

1.0 INTRODUCTION

Much has been written and said about the yield potentials of improved varieties over traditional varieties of rice. These optimistic views are supported by results of yield tests conducted using newly-developed rice varieties. Their higher yields are often taken as indications of their ability to generate higher economic returns.

The seeming success of the rice program rests on the mass dissemination and adoption of high-yielding rice seeds, coupled with the employment of recommended farm practices for these varieties. Most people agree that this temporarily solves the nagging problem of rice shortage in the country. In recent years, rice seed production and distribution has grown into a lucrative business and has attracted a good number of people with capital. Dealers of farm inputs, on the other hand, shared this boom. It can be said that the introduction of these high-yielding rice varieties caused a chain reaction in the agri-business sector. The trial plots in the field have spread over the whole cropland, an indication of farmers' acceptance of these new varieties.

The recommended cultural practices that go with the adoption of these high-yielding varieties generally require the employment of capital intensive inputs, especially fertilizers, insecticides and weedicides. Because most of our farmers are earning low incomes and are confronted with the problems of insufficient operating capital, it can be hypothesized that they make modifications on the application of required inputs even if they adopt improved varieties. It is also possible that some farmers apply these recommended cultural practices on traditional varieties especially when seeds of the HYV's are not available. This can happen in cases when the source of irrigation can be relied upon to hasten the effects of yield-increasing input.

It can be further hypothesized that farmers take into consideration expected profits forthcoming from the new varieties and improved practices. The same basis also serves as guide in employing improved practices on traditional rice varieties. In the final analysis, higher physical output is not the sole basis for accepting or rejecting new technologies. Expected additional renumeration has more weight.

[1/] Instructor and Research Assistant, Department of Agricultural Economics, U. P. College of Agriculture.

This study was conducted to fill in the information gap on the economics of producing the new HYV's. Thus, the following were the objectives:

1. To determine and compare productivity of farms producing traditional and improved varieties; and

2. To compare profitability of these varieties through cost and return analysis.

2.0 METHODOLOGY

The study made use of data gathered by means of personal interviews of farmers in two provinces covering crop year 1967/68.

In Laguna, the list of the Rice and Corn Productivity Coordinating Council (RCPCC) farmer-cooperators for the crop year 1967/68 was used as the sampling frame. Simple random samples were drawn from the list of farmers obtained from the RCPCC and the Agricultural Development Council for Rizal. These samples were drawn from among the top rice-producing towns of the provinces of Rizal and Laguna. A total of 244 farmers were interviewed, 100 from Rizal and 144 from Laguna.

3.0 RESULTS AND DISCUSSIONS

3.1 The study area

Laguna and Rizal are adjacent provinces surrounding the northeastern and southwestern portions of Laguna de Bay. As of 1960, the area planted to lowland rice was 21,807.60 hectares in Laguna and 11,462.10 hectares in Rizal.

Laguna may be considered as the first province that planted the IRRI and College varieties of rice due to having the International Rice Research Institute and the U.P. College of Agriculture within its boundaries. Both institutions are involved in the multiplication and to some extent dissemination of new rice seeds. Rizal, on the other hand, through its Agricultural Development Council, adopted the miracle rice varieties on a province-wide basis.

3.2 Resources in the farm

3.2.1. Human resources. In Laguna, out of the 144 farmers interviewed, 128 were share tenants and 31 were leaseholders. The average age of farmers was 44 years with an average educational attainment of 4 years. Farmers interviewed in Rizal were older, with an average age of 51 years and also with 4 years of education. Out of 100 farmers interviewed in Rizal, 58 were share tenants, 29 were owner-operators, and 13 were part-owners (Table 1).

The farmers in Laguna had been engaged in farming for 21 years, 16 years of which were spent on their present farms, while the farmers in Rizal had been in farming for 28 years, of which 24 years were spent on their present farm. Farmers in Rizal were generally older than farmers in Laguna. This could be partly attributed to the presence of so many factories in Rizal province which absorbed the majority if not all of the children of these farmers.

3.2.2. Land resources. The size of farms in Laguna, 2.39 hectares, was larger than the size of farms in Rizal which averaged only 1.39 hectares. Land use in Laguna was more intensive as evidenced by 83 percent double cropping as against 23.02 percent in Rizal farms. This would imply the presence of better irrigation facilities in Laguna (Table 2).

3.2.3. Labor resources. In both provinces the bulk of the labor (more than 70 percent) was supplied by hired laborers. Next to hired labor was the farm operator who supplied about 15 percent of total labor requirements (Table 3). The same table also shows that the improved varieties required more man-days than the traditional variety. For the improved variety the man-days spent per farm ranged from 118 to 141.63, while that of the traditional varieties was 71 to 126.83 man-days. This was due to the fact that improved varieties required more labor for weeding, spraying, fertilizing and additional hired labor to harvest the increment in rice output.

3.2.4. Capital investment. Capital investment per farm averaged ₱12,599.70 and ₱11,333.41 for Laguna and Rizal, respectively. For both provinces, land investment constituted the bulk of total capital investment, 95.5 percent in Laguna farms and about 85.6 percent in Rizal farms (Table 4).

3.3 Farm labor utilization

3.3.1. Labor input by source. As was previously mentioned, the bulk of labor utilized was hired. The remainder were supplied by the operator and family members. Hired labor was mostly employed in transplanting, weeding, harvesting and threshing of palay. However, hired labor was also employed in land preparation such as plowing and harrowing.

3.3.2. Labor utilization by operation, season and variety. In Laguna, harvesting, threshing and hauling combined required an average of 34.50 and 30.40 man-days during the wet and dry season, respectively. In the case of Rizal, the three operations used up to 39.18 and 28.73 man-days during the wet and dry

TABLE 1. Characteristics of lowland rice farmers in Laguna and Rizal, 1967-68.

ITEMS	Number Laguna	 Rizal
Numbers of farmers	144	100
Tenure status		
Share tenant	128[a]	58
Owner	-	29
Part-owner	-	13
Leaseholder	31	-
	Average	
Operator's age	44	51
Years in school	4	4
Years farming	21	28
Years operating present farm	16	24

[a] Farmer has more than 1 parcel with different tenure status.

TABLE 2. Land resource characteristics of lowland rice farms, Laguna and Rizal, 1967-68.

ITEMS	Laguna	Rizal
Number of farms	144	100
Average size per farm (Ha.)	2.39	1.39
Land use intensity		
Effective crop area (Ha.)	4.37	1.84
Land double-cropped	1.98	.32
% double cropped[a]	83	23.02

[a] $\% \text{ double cropped} = \frac{\text{land double-cropped}}{\text{average size per farm}}$

TABLE 3. Man-labor requirement of lowland rice farms by variety by season planted, Laguna and Rizal, 1967-1968.

Source of labor	LAGUNA								RIZAL							
	Improved				Traditional				Improved				Traditional			
	Wet		Dry		Wet		Dry		Wet		Dry		Wet		Dry	
	Man-days	Per-cent	Man-days	Per-cent	Man-days	Per-cent	Man-days	Per-cent	Man-days	Per-cent	Man-days	Per-cent	Man-days	Per-cent	Man-days	Per-cent
									per farm							
Operator	19.38	16	17.46	15	13.89	17	11.92	17	38.52	27.20	23.49	19.73	43.31	34.15	36.95	36.78
Family	9.72	8	9.74	8	9.82	13	8.62	12	9.40	6.66	7.32	6.15	10.70	8.44	8.70	8.66
Exchange	1.01	b/	1.20	1	0.50	b/	0.87	1	3.27	2.31	1.45	1.22	4.20	3.31	5.25	5.23
Hired	95.22	76	90.09	76	57.51	70	50.41	70	90.39	63.83	86.78	72.90	68.62	54.11	49.55	49.33
Total	125.33	100	118.49	100	81.72	100	71.82	100	141.61	100	119.04	100	126.83	100	100.45	100
									per hectare							
Operator	8.48	16	8.40	15	6.04	17	5.70	16	30.16	27.20	26.08	19.73	28.64	34.15	37.02	36.78
Family	4.26	8	4.69	8	4.28	13	4.10	12	7.39	6.66	8.13	6.15	7.08	8.44	8.72	8.66
Exchange	.45	b/	.60	1	.20	b/	.40	2	2.56	2.31	1.61	1.22	2.77	3.30	5.26	5.23
Hired	41.60	76	43.30	76	25.08	70	24.20	70	70.79	63.83	96.34	72.90	45.38	54.11	49.65	49.33
Total	54.79	100	56.99	100	35.60	100	34.40	100	110.90	100	132.16	100	83.86	100	100.66	100

b/ Less than 1 per cent.

TABLE 4. Capital investment per farm by variety and tenure, Laguna and Rizal, 1967-68.

ITEMS	Improved			Traditional		
	Tenant value	Owner value	Part-owner value	Tenant value	Owner value	Part-owner value
Laguna						
Land	14,141.00	-	-	9,877.00	-	-
Farm buildings[a]	70.79	-	-	70.88	-	-
Tools and equipment	74.73	-	-	57.37	-	-
Supplies	23.23	-	-	7.93	-	-
Work animals[b]	234.41	-	-	263.01	-	-
Others[c]	165.98	-	-	213.07	-	-
Sub-Total	14,710.14	-	-	10,489.26	-	-
Rizal						
Land	11,344.82	12,269.41	9,500.00	14,396.55	10,950.00	12,140.91
Farm buildings[a]	84.66	92.25	22.75	31.15	119.75	73.88
Tools and equipment	671.57	1,266.69	146.65	88.40	348.23	612.80
Supplies	34.60	66.61	20.43	21.44	35.61	40.58
Work animals[b]	804.74	802.05	1,044.37	715.17	972.50	1,132.77
Others[c]	226.48	295.02	385.00	308.94	283.58	154.61
Sub-Total	13,166.87	15,152.06	10,119.20	15,561.67	12,659.68	14,155.00
All farms		11,333.41			12,358.00	

a/ Refers to farm shed and farms owned by tenant.
b/ Work animals considered were carabao at working age.
c/ Others: In Laguna, consist of tractor; in Rizal, consist of other livestock in the farm.

season, respectively (Table 5). Harvesters and threshers were commonly paid a share in kind of 1/6, 1/7 or 1/8 of the total gross production. Some cases were observed in Rizal where the harvesters and threshers were paid in cash. A number of these farmers were cooperators of the Agricultural Development Council for Rizal who were obliged to sell all their produce to the Council for seed purposes.

Again in Laguna, some farmers also required the prospective harvesters and threshers to weed their rice farms in exchange for the privilege of harvesting. Distance of hauling from the farm to either the farmer's house or the landlord's house influenced also the number of days utilized in this operation. The same operation on a per hectare basis required 14.55 man-days and 15.08 man-days for the wet and dry season, respectively, in Laguna as against 28.20 man-days and 30.54 man-days during the wet and dry season, respectively, in Rizal. The yield of rice in Rizal was considerably higher than in Laguna.

Weeding ranked second in the number of labor man-days utilized. In Laguna, weeding utilized 26.95 man-days and 25.24 man-days for wet and dry season, respectively. In Rizal, weeding required 21.52 man-days and 34.50 man-days for the wet and dry season, respectively. Land preparation followed weeding in terms of labor utilization. It started from seedbed preparation and care up to the final harrowing. In Laguna, this operation amounted to 17.66 and 16.53 man-days per farm for the wet and dry season, respectively. In Rizal, this operation required only 25.11 and 21.30 man-days per farm during the wet and dry season, respectively.

A majority of the farmers in the two provinces used carabao for land preparation. Few used hand tractors. Most, if not all, of the farmers owned a carabao and for them to buy a hand tractor meant more capital and high maintenance and repair cost.

However, some farmers owned both a hand tractor and a carabao. Hand tractors were usually rented at the rate of ₱25 to ₱30 per day. The rental fee covers the payment for two operators plus the fuel and oil consumption of the tractor plus its maintenance and repair costs.

Transplanting, irrigating, replanting, fertilizing and spraying were the other operations requiring more labor man-days. The per farm and per hectare labor operations showed a similar pattern of distribution. About 5.27 and 5.48 man-days per hectare for the wet and dry season, respectively, are needed to do transplanting alone in Laguna. In Rizal, it is higher, requiring 15.16 man-days and 18.63 man-days per hectare for wet and dry season, respectively (Table 6). On a per farm basis in Laguna, it required 12.05 man-days and 11.40 man-days to transplant during the wet and dry season, respectively. In Rizal, it would

Farm Labor Utilization

TABLE 5. Labor utilization (man, animal, and tractor) per farm of lowland rice farms by variety, and season, Laguna and Rizal, 1967-1968.

Farm Operations	IMPROVED						TRADITIONAL					
	Wet			Dry			Wet			Dry		
	Man	Animal	Tractor	Man	Animal	Tractor	Man	Animal	Tractor	Man	Animal	Tractor
							LAGUNA					
Seedbed preparation & care	2.51	0.03	-	2.30	.03	-	2.04	.09	-	1.80	.11	.01
Plowing	6.50	3.44	1.34	7.24	3.15	1.48	5.59	3.24	0.74	4.64	2.77	.62
Harrowing	10.50	4.35	2.97	10.15	3.89	2.91	8.18	3.21	2.13	6.93	2.28	2.05
Repairing & cleaning dikes	6.03			5.59			4.16			3.50		
Transplanting	14			14.43			10.09			8.35		
Irrigation and draining	1.46			1.20			0.68			0.68		
Weeding and replanting	38.61			36.18			21.10			19.52		
Fertilizing	1.98			1.90			.84			.91		
Spraying	2.65			2.28			1.14			.90		
Harvesting, threshing and hauling	41.09			37.22			27.90			24.59		
Total	125.33	7.83	4.31	118.49	7.07	4.39	81.72	6.54	2.87	71.82	5.16	2.68

Table 5 (cont'd.)

Farm Operations	Improved						Traditional					
	Wet			Dry			Wet			Dry		
	Man	Animal	Tractor	Man	Animal	Tractor	Man	Animal	Tractor	Man	Animal	Tractor
						RIZAL						
Seedbed preparation & care	5.42	1.92	.03	3.61	1.13	.04	5.55	2.68	.13	4.46	2.08	-
Plowing	8.99	7.30	.86	6.27	3.74	1.64	12.49	11.78	.44	10.74	17.36	.81
Harrowing	12.64	11.07	.81	6.69	5.25	1.04	16.50	15.38	.22	8.96	8.58	.33
Repairing & cleaning dikes	8.20			5.49			8.48			4.61		
Transplanting	22.18			16.89			19.59			18.46		
Irrigation and draining	1.30			.96			.99			1.46		
Weeding and replanting	37.52			41.69			20.64			22.65		
Fertilizing	2.93			2.71			1.86			1.48		
Spraying	3.20			2.33			1.61			2.58		
Harvesting, threshing and hauling	39.23			32.40			39.12			25.05		
Total	141.61	20.29	1.70	119.04	10.12	2.72	126.83	29.84	.79	100.45	28.02	1.14

TABLE 6. Labor utilization per hectare of lowland rice farms by variety and season, Laguna and Rizal, 1967-1968.

Farm Operations	IMPROVED						TRADITIONAL					
	Wet			Dry			Wet			Dry		
	Man	Animal	Tractor	Man	Animal	Tractor	Man	Animal	Tractor	Man	Animal	Tractor
						LAGUNA						
Seedbed preparation and care	1.10	.01	-	1.12	.01	-	.89	.04	-	.86	.05	-
Plowing	2.85	1.50	.59	3.48	1.51	.71	2.44	1.41	.32	2.21	1.33	.30
Harrowing	4.59	1.90	1.30	4.88	1.87	1.40	3.57	1.40	.93	3.32	1.10	.98
Repairing and cleaning dikes	2.63			2.69			1.80			1.70		
Transplanting	6.13			6.93			4.41			4.02		
Irrigation and draining	.64			.58			.29			.31		
Weeding and replanting	16.87			17.39			9.18			9.37		
Fertilizing	.86			.92			.35			.43		
Spraying	1.16			1.10			.48			.43		
Harvesting, threshing, and hauling	17.96			17.90			12.19			11.79		
Total	54.79	3.41	1.89	56.99	3.39	2.11	35.60	2.85	1.25	34.40	2.48	1.28

TABLE 6. (cont'd)

Farm operations	Improved						Traditional					
	Wet			Dry			Wet			Dry		
	Man	Animal	Tractor	Man	Animal	Tractor	Man	Animal	Tractor	Man	Animal	Tractor
						RIZAL						
Seedbed preparation and care	4.24	1.50	.03	4	1.25	.05	3.67	1.77	.09	4.47	2.08	-
Plowing	7.04	5.72	.68	6.96	4.16	1.82	8.26	7.79	.29	10.76	17.40	.80
Harrowing	9.90	8.67	.64	7.43	5.83	1.15	10.91	10.17	.15	8.98	8.60	.33
Repairing and cleaning dikes	6.42			6.09			5.61			4.63		
Transplanting	17.37			18.76			12.95			18.49		
Irrigation and draining	1.02			1.07			.65			1.46		
Weeding and replanting	29.38			46.28			13.65			22.71		
Fertilizing	2.30			3.01			1.23			1.48		
Spraying	2.51			2.59			1.07			2.58		
Harvesting, threshing and hauling	30.72			35.97			25.86			25.10		
Total	110.90	15.89	1.35	132.16	11.24	3.02	83.86	19.73	.53	100.66	28.08	1.13

require 20.89 man-days and 17.68 man-days during the wet and dry season, respectively, as previously shown in Table 5.

Labor utilization by variety differed by province, as was shown in Table 5. In Laguna, the total labor utilized per farm for the improved varieties was 125.33 man-days and 118.49 man-days for the wet and dry season, respectively, as against 81.72 man-days and 71.82 man-days for wet and dry season, respectively, for the traditional varieties. In the province of Rizal, for improved varieties on the per farm basis, the total labor utilized was 141.61 man-days and 119.04 man-days for wet and dry season, respectively, as against traditional rice varieties with 126.83 man-days and 100.45 man-days during the wet and dry season, respectively. There was a big difference in the labor man-days in the two provinces. One reason was that the use of tractors in land preparation is higher in Laguna than in Rizal. Another reason is the dependence on rain of most rice farmers in Rizal; this highly affects the labor utilization, especially in land preparation. It was obvious that total labor utilized was higher in the wet than in the dry season in both provinces. For all the labor operations in Rizal, it was weeding and replanting that required most labor on a per farm as well as on a per hectare basis. The relatively smaller size of farms in Rizal enables the farmer to devote more of his time to weeding. Another reason for higher labor utilization in Rizal than in Laguna is the additional labor man-days utilized for harvesting, threshing and hauling the higher yields in Rizal, for both traditional and improved varieties.

3.4 Analysis of the farm business

3.4.1. Varieties planted. In the two provinces, most of the farmers planted IR8 (Table 7). This variety, which came out in 1966, became popular with the farmers during this period. The government campaigned for the planting of IR8 because it is high-yielding. In Laguna, the presence of UPCA and IRRI caused the wide distribution of this variety; in Rizal, the Agricultural Development Council for Rizal was in charge of a local government program of seed multiplication for IR8.

For the additional varieties, Intan was predominantly grown in Rizal and Malagkit and Intan in Laguna.

3.4.2. Production per hectare by variety and by season. Yield was higher in Rizal than in Laguna (Table 8). Laguna farms studied averaged 77.79 cavans per hectare for the improved and 71.55 cavans per hectare for the traditional varieties. On the per farm basis, improved varieties produced 366.89 cavans during the year. Output of traditional varieties was 279.12 cavans per farm. During the wet season, lower yields were obtained for the two groups of varieties because of the typhoon that hit the country during that year, 1967-68.

TABLE 7. Varieties planted by lowland rice farms, Laguna and Rizal, 1967-68.

Varieties	Number of farms reporting[a/]			
	Laguna		Rizal	
	Wet	Dry	Wet	Dry
Improved				
IR8	87	80	38	30
IR5	1	-	-	-
C4-63	1	12	8	5
C18	3	2	-	-
BPI-76	-	2	4	-
Traditional				
Intan	17	29	16	-
Wagwag	-	10	4	-
Thailand	6	2	-	10
Liliwa	2	-	-	-
Surigao	2	-	-	-
Binato	1	1	-	-
Tjeremas	3	2	-	-
Malagkit	33	12	-	-
Macan	-	-	7	-
Consejala	-	-	3	-
BE-3	-	-	6	-
Raminad	-	-	6	6
Ramelon	-	-	5	-
Serup Ketchil	-	-	3	-
Total	156	152	100	51

[a/] Some farmers planted more than 1 variety.

TABLE 8. Production by variety and season, Laguna and Rizal, 1967-68.

Items	Laguna		Rizal	
	Improved	Traditional	Improved	Traditional
Number of farms	83	61	50	50
		Cavans		
Production per farm				
Wet season	182.10	132.60	115.11	104.80
Dry season	184.80	146.53	99.56	96.46
Average for the year	366.89	279.12	187.12	135.67
Production per hectare				
Wet season	75.47	62.44	68.48	74.21
Dry season	80.22	82.42	115.56	118.99
Average for the year	77.79	71.55	92.02	96.60
Price per cavan				
Wet season	14.53	22.95	20.01	19.64
Dry season	15.80	17.76	16.33	19.79
Average for the year	15.16	20.35	18.17	19.71

Typhoon Welming damaged palay about to be harvested. As a consequence, because storage and drier facilities were inadequate, palay saved from the flood was damaged by molds and had to be sold at low prices.

In Rizal, the effect of typhoon Welming was not as severe. The production per farm averaged 195.67 cavans for the traditional and 187.12 cavans for the improved varieties. Per hectare, the yields were almost the same for improved and traditional varieties, 92.02 and 95.60 cavans, respectively. For both types of rice varieties, the yield per hectare during the dry season was obviously higher than the yield during the wet season.

3.4.3. Cost and returns per farm per hectare. As shown in Table 9, improved varieties had a higher total cost of producing palay than traditional varieties. In producing improved varieties, total cost per farm was ₱1,679.89 and ₱1,417.92 for the wet and dry season, respectively. For the traditional varieties, total cost incurred per farm was ₱1,555.17 and ₱1,141.33 per farm for wet and dry season, respectively.

In Laguna, the total cost of producing improved varieties was ₱2,163.00 and ₱2,248.35 per farm for the wet and dry season, respectively. Again, the trend was the same for Rizal, the total cost incurred for traditional varieties was ₱1,999.55 and ₱1,926.55 per farm for wet and dry season, respectively.

On a per hectare basis, the net gain from producing improved varieties was higher, especially in the dry season. In Laguna, during the dry season, the net gain for growing improved varieties was ₱349.43 per hectare as against that of traditional varieties with ₱398.70 net gain per hectare (Table 10).

In Rizal, the situation was similar. Growing improved varieties gave a net gain of ₱684.97 per farm or ₱476.73 per hectare during the wet season and ₱400 per farm or ₱403.80 per hectare net gain during the dry season. This gain was much higher than in Laguna because the production in Rizal was higher than in Laguna.

As for the traditional varieties, the net gain per hectare was ₱265.97 and ₱183.84 during the wet and dry season, which is only one half of the net gain from the improved varieties.

The costs and returns on a per cavan basis followed the same pattern as shown previously in Table 9.

Non-cash costs for the two varieties greatly exceeded the cash expenditure of the farm during both seasons.

TABLE 9. Costs and returns of producing improved and traditional varieties.

	LAGUNA				RIZAL			
	Improved		Traditional		Improved		Traditional	
ITEMS	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
pesos per farm								
Cash costs	674.08	645.34	412.13	394.83	420.19	414.55	230.90	212.27
Non-cash costs	1488.92	1603.01	1587.42	1531.72	1259.70	1003.37	1324.27	929.06
Total costs	2163.00	2248.35	1999.55	1926.55	1679.89	1417.92	1555.17	1141.33
Total returns	2791.63	3053.31	2766.03	2635.32	2364.86	1818.53	1993.10	1519.87
Net gain	628.63	804.96	766.48	708.77	684.97	400.61	437.93	378.54
pesos per hectare								
Cash costs	279.37	280.14	194.08	222.10	313.57	460.61	163.76	262.06
Non-cash costs	617.07	695.87	747.57	861.63	940.07	1114.86	939.20	1146.99
Total costs	896.44	976.01	941.65	1083.73	1253.64	1575.47	1102.96	1409.05
Total returns	1156.96	1325.44	1302.62	1482.43	1729.86	1979.27	1368.90	1592.89
Net gain	260.52	349.43	360.97	398.70	476.73	403.80	265.97	185.84
pesos per cavan								
Cash costs	3.70	3.49	3.11	2.69	3.65	4.16	2.20	2.20
Non-cash costs	8.18	8.67	11.97	10.45	10.94	10.08	12.64	9.63
Total costs	11.88	12.16	15.08	13.14	14.59	14.24	14.84	11.83
Total returns	15.33	16.52	20.86	17.98	20.54	18.20	19.00	15.70
Net gain	3.45	4.36	5.78	4.84	5.95	3.96	4.16	3.87

TABLE 10. Measures of returns of lowland rice farms per farm, per hectare, per cavan, by variety and season, Laguna and Rizal, 1967-68.

Items	LAGUNA				RIZAL			
	Improved		Traditional		Improved		Traditional	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
					per farm			
Returns above cash costs	2117.55	2407.97	2353.90	2240.49	1944.67	1403.98	1762.20	1307.60
Returns above non-cash costs	1302.71	1450.30	1178.61	1103.60	1049.52	815.16	668.83	590.81
Net gain	628.63	804.96	766.48	708.77	684.97	400.61	437.93	378.54
Net farm income	772.07	937.78	922.99	839.67	1148.75	782.96	766.43	610.22
Ret. to operator's labor	745.14	910.44	879.41	806.27	817.90	476.87	570.59	471.55
Ret. to capital	655.57	832.29	810.06	742.17	1015.82	705.13	633.77	516.67
% return to capital	3	3	3	3	8.96	6.22	5.12	4.18
					per hectare			
Returns above cash costs	877.59	1045.30	1108.54	1260.33	1416.29	834.31	1205.17	1330.83
Returns above non-cash costs	539.89	629.57	555.05	620.80	476.22	460.33	429.73	445.90
Net gain	260.52	349.43	360.97	398.70	476.73	656.90	265.97	183.84
Net farm income	319.97	407.09	434.67	472.34	822.83	1082.41	498.95	470.53
Ret. to operator's labor	308.81	395.22	414.15	453.57	575.93	743.38	360.06	299.33
Ret. to capital	271.69	361.30	381.49	417.49	723.63	995.93	404.86	355.04
% return to capital	3	3	3	3	8.61	11.85	4.62	4.05

Among the non-cash cost items, the landlord's share for the use of the land was the largest non-cash cost item, followed by harvester's and thresher's share. Among the cash cost items, hired labor was the biggest.

Total farm returns, measured by the value of palay produced plus the increase in farm inventory, amounted to an average of P2,482.40 per hectare for improved varieties and P1,392.52 per hectare for traditional varieties in Laguna. Total farm returns in Rizal were higher, with P1,729.86 per hectare for improved and P1,368.93 for traditional varieties during the wet season.

The returns per cavan followed the same trend, higher in improved than in traditional varieties. In Laguna, the total cost per cavan was P14 for the two types of varieties as shown previously in Table 9. In Laguna, return per cavan was higher for the traditional varieties; in Rizal, however, the improved varieties had a higher return per cavan in both wet and dry season than traditional varieties.

3.4.3. Measures of income. In addition to net gain, other measures were used to determine farm income. One of these was the return above cash costs as shown in Table 10. This was obtained by deducting all cash costs incurred in production from the total farm returns. As previously mentioned, improved varieties had a higher return than the traditional varieties in both provinces. On a per farm basis, in Laguna, P2,262.76 and P2,297.19 were the returns above cash cost for improved and traditional rice varieties, respectively. The per hectare and per farm returns followed similar patterns, as shown in Table 10.

In Rizal, the returns above cash cost ranged from P1,674.33 per hectare for the improved to P1,035 per hectare for the traditional varieties.

Another measure of farm income was the return above non-cash costs. It was computed by subtracting the total non-cash costs from the total farm returns. It followed the same pattern as the returns above cash cost for both provinces.

Returns to operator's labor and capital was also measured in terms of the net farm income. This was obtained by subtracting all farm expenses, both cash and non-cash costs excluding interests on capital and value of operator's labor, from total farm receipts.

Returns to operator's labor would be another measure of returns. It was used to measure the income from labor of the operator and was obtained by deducting the interest on average capital investment from the net farm income. As was hypothesized, return to operator's farm labor was highest in the improved variety in both provinces. In Laguna, it is P352.01 per hectare from the improved varieties as compared to P433.86 per hectare in the traditional varieties. In Rizal, it followed the same pattern, P659 per hectare for the improved varieties and P325 per hectare for the traditional varieties.

Percent return to capital represents the rate of earnings of the capital invested in the farm business. It was also used to measure the percent return to capital invested in the growing of these two types of varieties. This measure was obtained by dividing the returns by capital investment for the year. This is a useful measure because it could serve as a guide in determining the opportunity cost of the capital invested in rice farming. On a per farm basis, the percent return to capital per farm was higher in Rizal than in Laguna. In Laguna, the capital invested in improved and traditional varieties both earned an interest at the rate of 3 percent per farm and 3 percent per hectare. In Rizal, the percent return to capital was higher in the improved varieties, both on a per farm or a per hectare basis, as shown in Table 10.

4.0 SUMMARY

This paper shows the partial results on the costs and returns of growing improved and traditional rice varieties in the two provinces of Laguna and Rizal. The introduction of high-yielding or improved varieties together with the package of cultural practices and inputs brought about an increase in the farm income of farmers. The increase per hectare was nearly doubled for the improved varieties. Several studies reported that the cost of production per hectare was almost doubled for the improved varieties; this increase in the cost of production can be attributed to an increase in cash costs. This study also found that the improved varieties required more inputs in the form of seeds, fertilizer and chemicals. Labor inputs for caring for the plant, such as weeding, were also increased thus incurring additional cash costs. For harvesting and threshing, more had to be paid to handle the increase in yields. In Rizal, the Agricultural Development Council for Rizal was one of the extension arms of the Governor in its role of supporting the program of increased production of improved varieties. It has a price support program for IR8 produced seeds which greatly helped the farmers in Rizal. In Laguna, due to the normal operation of the law of supply and demand, the prices of the improved varieties went down to as low as P14.50 per cavan in 1967-68. Another problem faced by Laguna farmers is the low quality of rice due to the lack of drying facilities. Farmers without the facilities for drying or without access to a dryer were forced to sell their rice during harvest season at very low prices, to prevent the palay from accumulating molds and finally rotting.

The presence of a regular source of irrigation plays an important role in the acceptance of improved varieties. Several farmers, when asked why they were still planting traditional rice varieties, said that it is very risky to venture into this business of planting improved varieties if you are only depending on rain for irrigation. In other words, physical factors like irrigation are critical in deciding whether to plant improved or traditional rice varieties.

INCOME DISTRIBUTION PATTERNS OF RICE FARMS IN BICOL

Moises L. Sardido[1]

1.0 INTRODUCTION

The attainment of national self-sufficiency and exportable surplus is a widely acknowledged technological breakthrough of rice production in the Philippines. A higher rice output growth, however, creates new policy problems.

Initially, only farmers with better resources adopt new technology, and the higher profits obtained by these farmers may lead to a widening of the income distribution. Higher rice yields come mostly from lowland irrigated paddies accompanied by higher levels of technical inputs in the adoption of new varieties. This seems to suggest that there exists a widening gap in the income distribution in agriculture, both within and between types of farms.

Secondly, the prospects of an export market for the Philippine rice appear not too promising. As other countries strive for self-sufficiency the total amount of rice traded internationally is declining along with world prices, and the export market is becoming extremely competitive.[2]

In the farm level, the impact of increased rice production and declining rice prices will in turn affect resource allocation. Previous studies on hectarage competition between rice and other crops, showed that Philippine farmers are responsive to price changes.[3] In areas where farmers can produce a variety of alternative crops, changes in rice price would cause a shift in hectarage utilization of farms. In theory, the marginal rate of substitution among crops will be equal to the ratio of their prices at the most profitable point.

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[1] Research Scholar, Department of Agricultural Economics, International Rice Research Institute.

[2] See: (a) Efferson, J. N. and Sengelmann, K., "An Appraisal of Rice Drying, Storage, Processing and Marketing in the Philippines," October 1969, The Ford Foundation, Manila. (b) Barker, R., "The World Rice Market and the Philippine Strategy for Export," Paper presented at the seminar on Rice Consumption and Marketing in the Philippines, December 5-6, 1969, IRRI.

[3] See: (a) Mangahas, M., Recto, A. E. and Ruttan, V. W., "Price and Market Relationships for Rice and Corn in the Philippines," Journal of Farm Economics, Vol. 48, No. 3, Part I, Aug. 1966, pp. 685-703. (b) Antiporta, Donato, "Competition for Hectarage: Rice Against Other Crops," Undergraduate Thesis, UPCA, 1965 (unpub.), Appendix summary of land utilization.

In anticipation of the above problems, alternatives to rice become important in terms of increased income and productivity of resources. One of the research areas advocated is the development of multiple cropping with rice.[4]

At present multiple cropping with paddy rice is not practiced intensively in the Philippines. In Japan and Taiwan, however, the system has long been reported with success, and it is believed by advocates that its potential is promising in the Philippines as elsewhere in the tropics. Thus an experimental work, such as that of IRRI in Los Baños, is being conducted.[5]

But multiple cropping systems are determined by many factors, such as natural conditions, soil, irrigation, availability and type of labor, capital, cultural practices, and the level of farmers' knowledge.[6] Among these, irrigation or effective water control, capital and farmers' knowledge, and cultural practices appear as technical constraints at present to the adoption of intensive multiple cropping with paddy rice in Philippine farms. Marketing problems of vegetables and root crops must also be solved before a profitable multiple cropping scheme could be achieved by farmers. It is, therefore, necessary to examine the rice

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4/ For background statement of this alternative see: (a) Barker, R., "Economic Problems Associated with Increased Rice Supplies," Paper presented at IRRI Rice Research Conference, April 28 - May 2, 1969, IRRI, mimeo. (b) Barker, R., "Economic Aspects of High-Yielding Varieties of Rice, With Special Reference to National Price Policies," FAO Monthly Bulletin of Agricultural Economics and Statistics, Vol. 18, No. 6, June 1969. (c) Bradfield, R., "Opportunities for Increasing Food Production in Tropical Regions by Intensive Multiple Cropping," Paper presented at the meeting of the American Association for the Advancement of Science held on Dec. 1968, Dallas, Texas.

5/ A recently established multiple cropping department headed by Dr. Richard Bradfield, who initiated the project at IRRI experiment station in 1965, has already attracted attention for its technical success in developing multiple cropping scheme. There is yet, however, no report of an analysis of its economic aspects in terms of costs and returns and basic resource requirements as guide for farm recommendations.

6/ For a discussion on multiple cropping practices see: (a) Wong, C. T., "Enlarging the Size of Farm Business Through Intensive Land Use in Hong Kong," in Farm Management Notes for Asia and the Far East, FAO, Bangkok, Thailand, Vol. IV, No. 2, July 1968. (b) Sawamura, Tohei, "A Study on the Cropping System of the Paddy Field in Japan," Bulletin of the National Institute of Agricultural Sciences, Series H, No. 2, July 1957, Nishigara, Tokyo, Japan, p. 191.

cropping systems now found in the Philippines and to determine under what conditions multiple cropping is likely to expand. Towards this goal, an exploratory study may provide a basis for further detailed investigations on the economics and technical aspects of multiple cropping in the Philippines. Hence, a study on income distribution, resource use and cropping patterns is being conducted in the Bicol region of the Philippines. The province of Albay was chosen as the location of the study since multiple cropping was known to be practiced in this area.

This paper is a preliminary report of a part of the study. It only covers the following among the objectives of the study:

1. Identify farm production patterns that exist for rice and for alternatives to rice in Albay Province, Bicol.

2. Establish resource use, cost, and returns of farms with typical cropping patterns.

3. Establish the income distribution pattern for farms both within and between these typical crop pattern groups.

4. Determine the impact that the introduction of new varieties has had upon the income distribution pattern for these farms.

2.0 METHODOLOGY AND ANALYSIS

2.1 Sources and collection of data

The farm survey method was employed in the collection of data through personal interviews with sample farmers. Sample farms were selected by multistage and double-sampling scheme.

The first large sample (N = 382) survey was conducted in April 1969, just immediately after the harvest of second crop of palay. This was mainly intended for the first objective, i.e., to identify the farm production patterns which exist for rice and for alternative crops in Albay province. Sample farmers were asked to state their crop hectarage from crop year 1964/65 to 1968/69. Then based on 1968/69 crop year farms were classified by cropping patterns. This provides the basis for selecting the farm types considered in the study.

The three typical types of rice farms or cropping patterns included in the second phase of the survey are:

1. All lowland rice farms irrigated (LL).

2. Lowland rice and other crop farms (LO), where lowland rice field is irrigated either with one or two crops of palay.

3. Upland rice and other crops (UO).

The sample farms drawn for each type was proportional to the large samples or phase I survey. Thus, the sample sizes were 51, 27, and 23 for LL, LO, and UO, respectively.

The sample farm households were interviewed on their farm production for crop year 1968/69. Other information which was used for the analysis was also recorded in the prepared interview schedules.

2.2 Income analysis

Farm income was initially measured as return above variable costs. This is computed by deducting total variable costs from total farm crop receipts. Value of crop receipts is calculated by multiplying total production by actual price received by farmers during sales of their crops. Quantity for home use and products not sold or held for sale were valued at the prevailing price during the survey.

Items for variable costs are expenses for hired labor, seeds, fertilizers, insecticides, weedicides, and other miscellaneous expenses such as rent for use of tools and equipment, work animals, and transportation costs for transporting supplies and products. Hired labor which constitutes the highest item of variable costs includes the value of services for harvesting and threshing of palay.

In all farm types, incomes from livestock were not considered. These were either very small to be negligible or none at all. Farmers with poultry and livestock as one major source of farm income were intentionally excluded from the sample farms. This income measure (return above variable costs) was used in analyzing the income differences between farm types and income distribution patterns within and between the farm types. The method used in analyzing the nature of income distribution are briefly described in the presentation of results. Selected economic or management factors associated with income were also analyzed to explore their relevance. As in the case of income, the analysis of these factors are mainly descriptive, largely on their average gross relations to income variations. Further analysis by regression and correlation is not included in this presentation.

3.0 DISCUSSION OF RESULTS

3.1 Farm alternatives and cropping patterns in Albay

The major crops in Albay are rice, abaca, coconuts and several of vegetables and fruits. Twelve of the 17 municipalities of Albay have rice as one of the major crops, while the 5 other municipalities do not include rice as one of the major crops but just one of the minor crops, which are generally upland rice and rainfed paddies. Farming barrios and suburbs of Legaspi City have rice and vegetables as major crops.

Table 1 shows the effective crop area utilization from crop year 1964/65 to 1968/69, estimated from the present survey.

Historically, Albay has been one of the top provinces in the production of abaca. But, this crop appears to be less important at present than before 1960. The decline of this crop is not only true in the province but is nationwide - in all major abaca-producing areas, except Eastern Visayas,[7/] due to the falling export market which has also been preceded by the mosaic disease devastation. From 1960 to the present, apparent shift from abaca to other crops is evident. Palay hectarage also showed a slight decline in the last two crop years.

Except for the above-mentioned shift in abaca to other crops, there has been not much changes in cropping pattern in the area. For rice, the generally fixed hectarage and cropping pattern is largely due to the presence or absence of irrigation water supply than any other important single factor. Where water is available, two crops of rice is normally grown on most lowland rice farms which are generally known as the wet and dry or the first and second crop of rice.

In the rainfed or water-deficient lowland rice farms, farmers either plant only one crop (wet season) or a significantly decreased hectarage for the second crop of rice (dry season). Short season crops, mainly root crops and vegetables, are planted in dry months in rotation with rice or separate areas in diversified rice farms.

Other major crops which are perennial in nature, particularly coconuts, abaca, and some fruit trees, are mostly planted in higher topography areas and where irrigation is a difficult prospect. In these upland areas, upland rice is one of the major field crops.

[7/] See Antiporta, Donato, op. cit.

TABLE 1. Percent effective crop area utilization, crop years 1964/65 to 1968/69, Albay.*

Crop**	1964-65	1965-66	1966-67	1967-68	1968-69
Palay	34.28	34.78	34.31	33.31	33.12
Coconut	15.99	15.79	16.15	16.98	16.84
Abaca	11.86	11.69	11.63	10.74	10.86
Corn	4.51	4.49	4.86	4.77	4.93
Misc. root crops	14.72	14.84	14.39	14.63	14.91
Banana	5.82	5.80	5.73	5.78	5.60
Vegetables	8.60	8.36	8.61	9.75	9.83
Misc. fruit crops	1.32	1.37	1.40	1.27	1.28
Peanuts	1.05	1.05	1.06	1.06	1.08
Coffee	0.94	0.93	0.94	0.91	0.69
Cocoa	0.91	0.90	0.92	0.90	0.85

* Estimate is based on 382 sample farms from 19 sample barrios of 5 sample towns, with sampling units in all stages drawn with equal probability.

** Crops less than .50% of total area are excluded, e.g. sorghum.

Presently, however, farmers as individual producers still consider rice as a priority crop, and will likely remain to dominate most farmers' cropping program for the logical reason of its being the staple food item for the farm family. Multiple cropping with vegetables and root crops along with an integrated crop and livestock program hold great potential for the area should price relationships become unfavorable to rice. Soil and climatic conditions and potential for irrigation favor multiple cropping, especially vegetables.

Based on crop year 1968/69, the sample farms were classified according to crops grown or general cropping patterns. Table 2 shows that according to the percent of farms observed the typical rice farms are all-rice lowland irrigated, lowland rice and other crops (where lowland rice is irrigated), and upland rice and other crops.

3.2 Comparison of income by farm types

As stated earlier, only three types of rice farms or cropping patterns are considered in this study: (1) all lowland rice irrigated, 2 crops (LL), (2) lowland rice irrigated (1 or 2 crops rice) and other crops (LO), and (3) upland rice and other crops (UO).

The average farm income by type of farm is presented in Table 3. The t-test showed that the difference in income per farm and per hectare between LL and LO farms are not statistically significant at 5 percent level of significance. This was due to the very high variability in the individual farm income. However, UO farm income is significantly lower than both the LL and LO farms per farm and per hectare. The income comparison seems to indicate that UO farms are the least productive among the three types of farms.

3.3 Income distribution patterns

Frequency histogram, Lorenz Curve, and Gini Ratio are used in analyzing the nature of the income distribution patterns. Greenwald (1963)[8] stated that whenever inequality or concentration in some factors is being measured, a Lorenz Curve, which uses an arithmetic scale, is most commonly employed. Boyne (1965)[9] considered the Gini Ratio as a useful tool to summarize the degree of concentration of a given income distribution.

8/ Greenwald , W. I., Statistics for Economics (Maruzen Asian Edition), Charles E. Merrill Books, Inc., Maruzen Company, Ltd., 1963, pp. 24-26.

9/ Boyne, David H., "Changes in the Income Distribution in Agriculture," Journal of Farm Economics, Dec. 1965.

TABLE 2. Type of cropping pattern, Albay, 1968-69.*

Type	Percent
Lowland rice only	
Irrigated	38
Non-Irrigated	3
Lowland rice and other crops	
Irrigated (rice)	21
Non-Irrigated (rice)	4
Upland rice only	1
Upland rice and other crops	17
Other crops (no rice)	16
Total	100

* Estimate is based on 382 random sample farmers from 19 sample barrios of 5 sample towns.

TABLE 3. Comparison of income (return above variable costs) by type of farm, Albay, 1968-69.

Farm type[1]	Mean[2] (₱)	Lower limit .05	Upper limit .05
Per farm			
LL	1130. a	766	1495
LO	1475 a	795	2154
UO	255 b	171	338
Per hectare			
LL	841 a	698	984
LO	932 a	701	1163
UO	205 b	150	259

[1] LL - All-rice lowland rice farms, 2 crops irrigated.
LO - Lowland rice and other crop farms, with lowland rice irrigated either one or 2 crops.
UO - Upland rice and other crop farms.

[2] Any two means followed by the same letter are not statistically different at 5% level of significance.

The Gini Ratio is derived from the Lorenz Curve. It is a concentration ratio, suggested by Gini, which measures the area of concentration of income to the area of the maximum possible concentration. The ratio equals zero if there is perfect equality, and unity if there is perfect inequality.

Figure 1 shows the per farm distribution of income between the three types of farm, while Figures 2, 3 and 4 show the per farm distribution within farm types. It is apparent that income distribution is a function of farm type and size of farms. To remove the effect of farm size, a per hectare distribution is shown in Figure 5.

Table 4 and Figures 6 and 7 provide comparison of the inequality of income distribution of three selected farm types, their combined distributions, and the palay farm income among lowland rice farms.

The Gini Ratio shows the degree of inequality of farm income distribution attributed to farm types both per farm and per hectare. Within each farm type, there is also relatively more concentration of higher income towards a few farms. Comparing the degree of concentration between farm types, the "Gini Ratio" shows that there is a higher concentration among LO than LL farms, while among UO farms, there is a lesser degree of income inequality. As shown by the "Gini Ratio" it may be suggested that farm income distribution per hectare will vary less among farms of the same type.

3.4 Impact of the introduction of new varieties on the income distribution pattern

Numerous studies both experimental and farm surveys have consistently indicated the economic benefits in terms of increased income from the new and improved varieties. One objective of this study is to determine the impact that the introduction of new varieties has had on the income distribution pattern on typical farms.

Figures 8 and 9 are a per farm income distribution of income of LL farms, which are purely rice lowland farms. It is clearly shown that only farms with new varieties achieved income levels higher than P600 per farm. But this does not eliminate the effect of farm size.

Figures 10 and 11, with effect of farm size eliminated, show the effect of new varieties on the income distribution per hectare of all rice farms (LL, LO). There is a slight difference between the two seasons, except for an isolated case during the second crop, where a few farmers planting local varieties achieved the same highest income level as the new varieties. Close examination of these farms, however, revealed that these farms did not employ much hired labor, which explains the high return above variable cost. Hired labor is the highest single variable cost item among the farms.

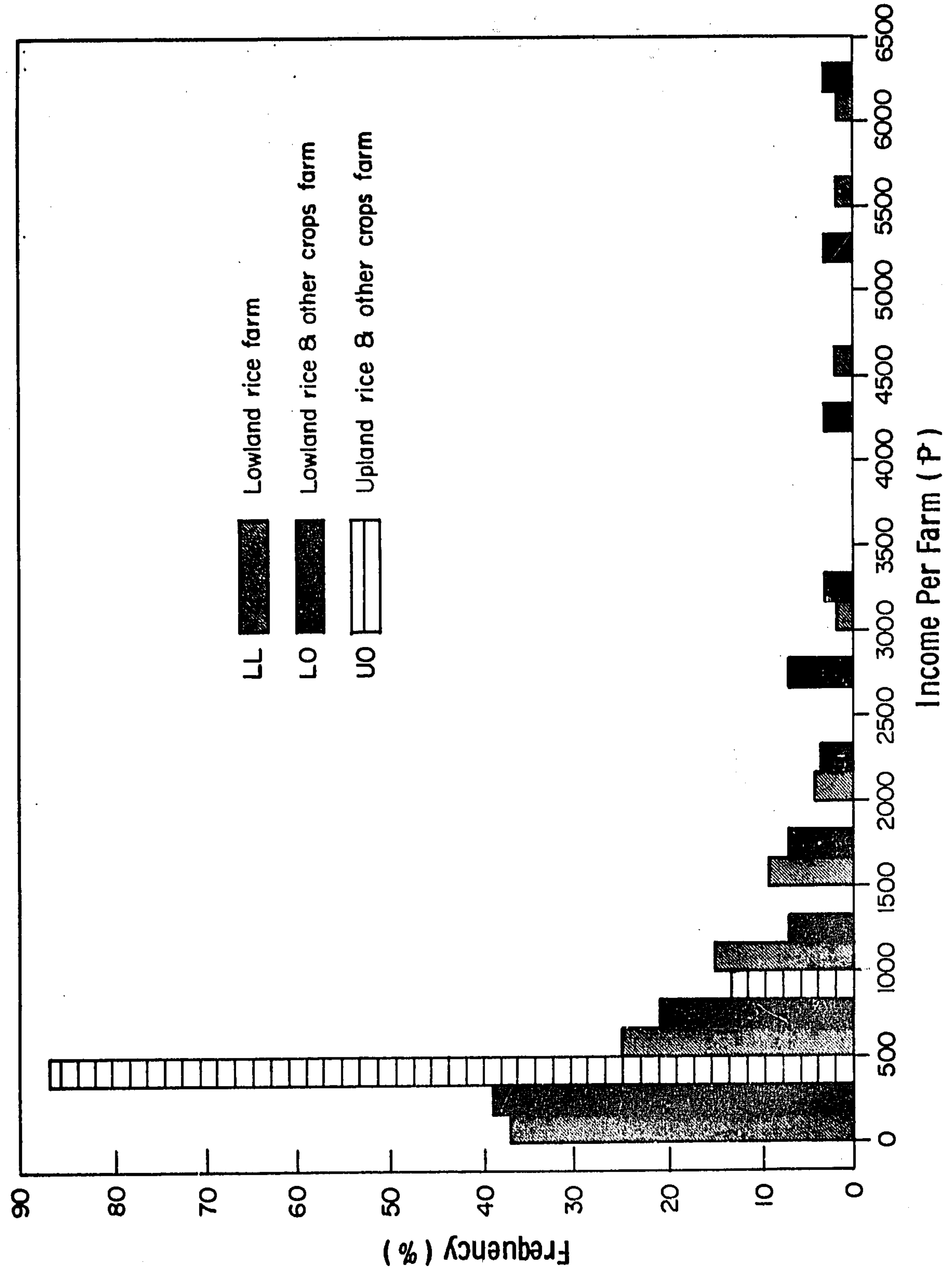

Fig. 1. Per farm income distribution (return above variable costs) of three types of farm, Albay, 1968-1969.

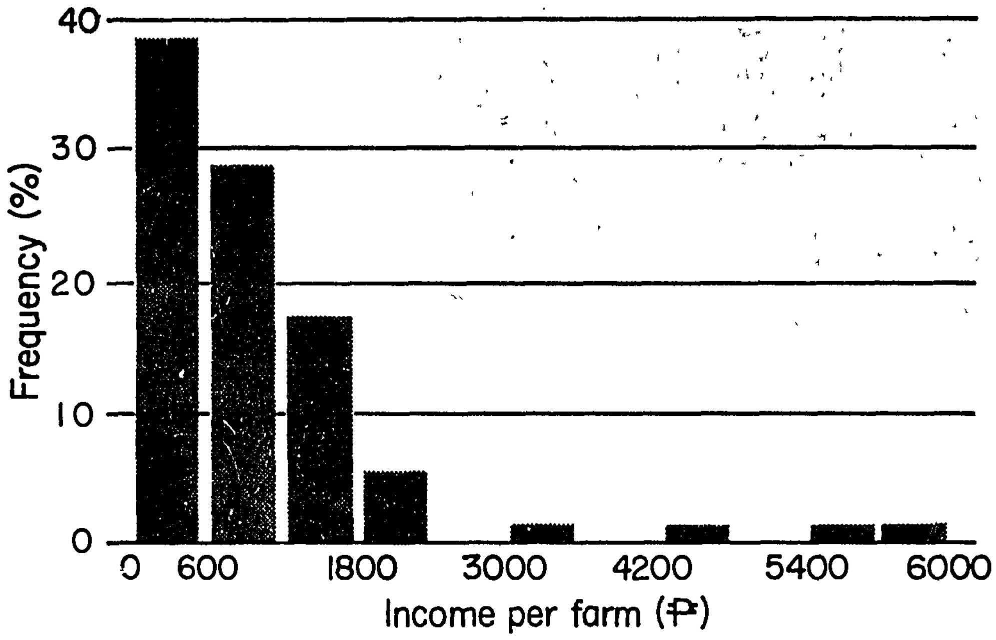

Fig. 2 Per farm income distribution pattern (return above variable costs) within lowland rice farms (LL), Albay, 1968-1969.

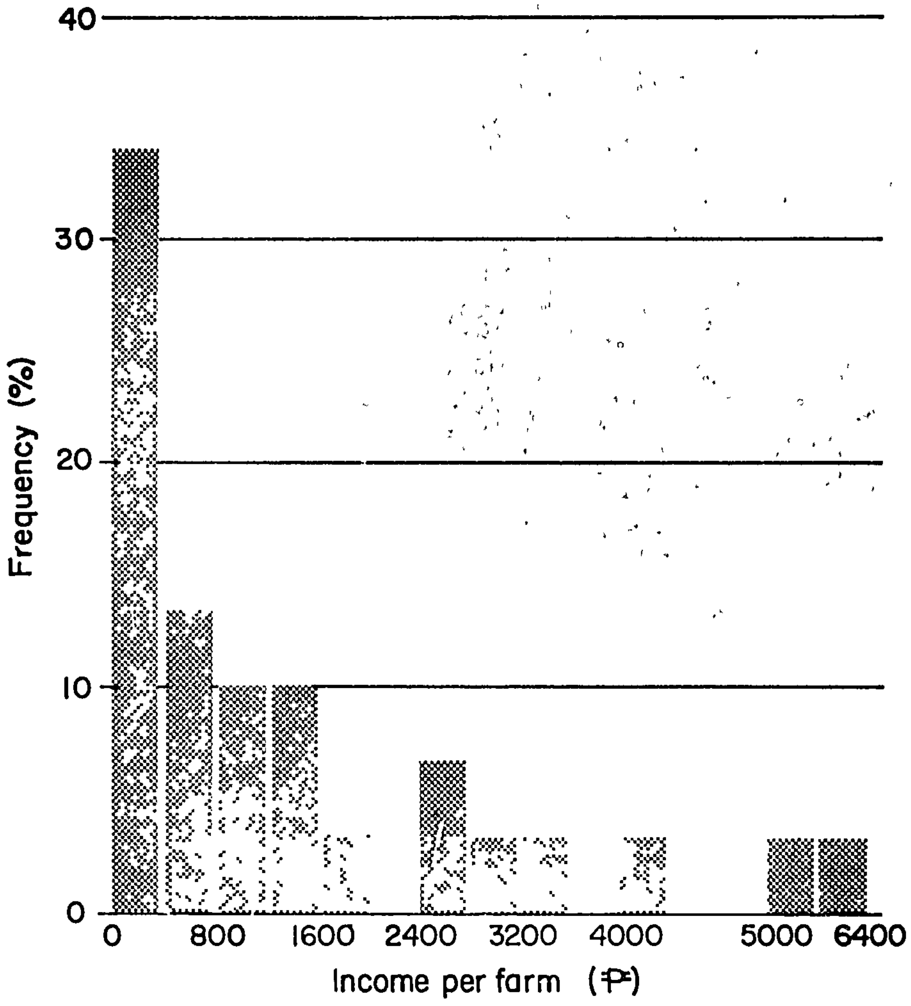

Fig. 3. Per farm income distribution pattern (return above variable costs) within lowland rice and other crops (LO) farms, Albay, 1968-1969.

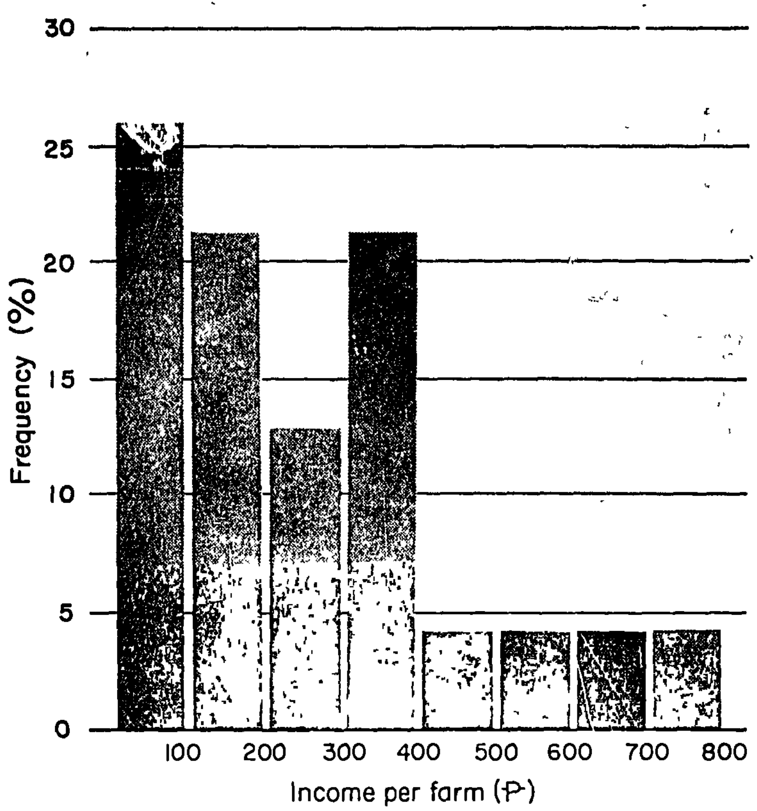

Fig. 4. Per farm income distribution pattern (return above variable costs) within upland rice and other crops (UO) farms, Albay, 1968-1969.

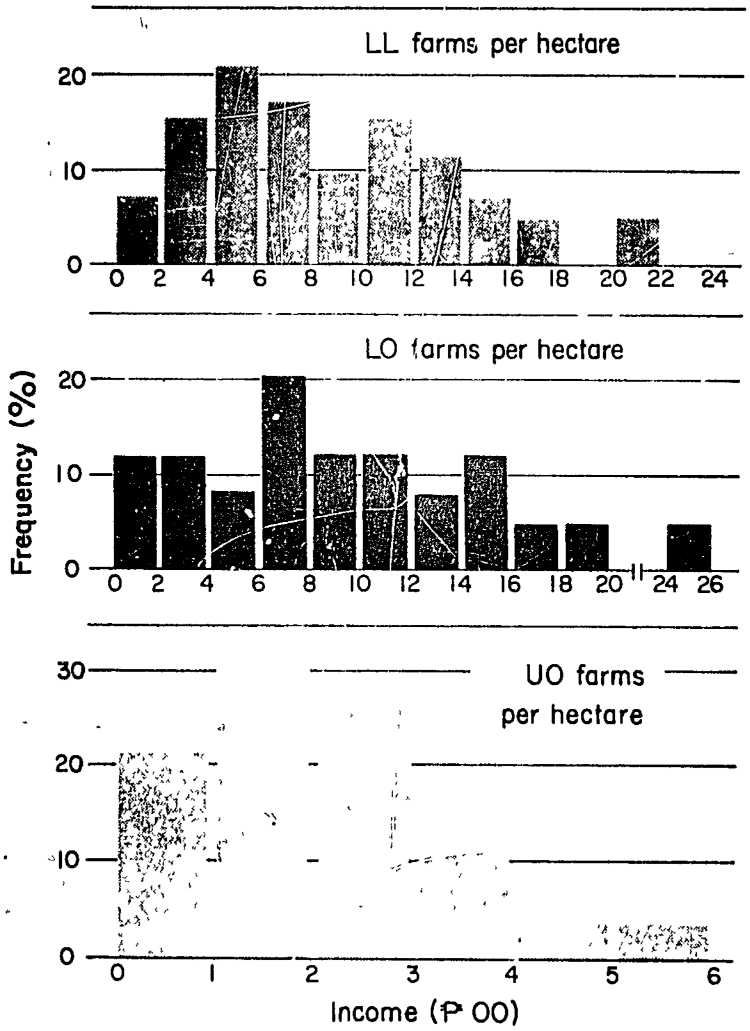

Fig. 5. Comparative farm income per hectare distribution patterns of three types of farm, Albay, 1968-1969.

TABLE 4. Gini Ratio of the distribution of income (return above variable cost), Albay, 1968-1969.

Farms	Gini Ratio (R)
Per farm	
Lowland rice (LL)	0.48
Lowland rice and other crops (LO)	0.56
Upland rice and other crops (UO)	0.40
All farms combined (LL, LO, UO)	0.55
Per hectare	
Lowland rice (LL)	0.33
Lowland rice and other crops (LO)	0.36
Upland rice and other crops (UO)	0.31
All farms combined (LL, LO, UO)	0.41

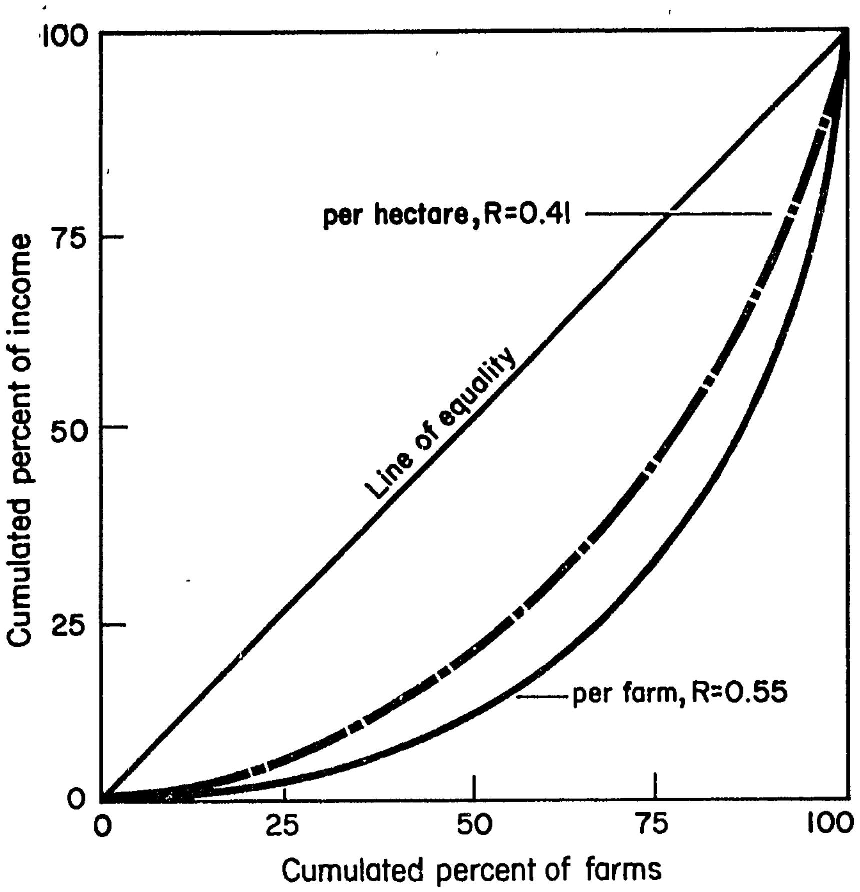

Fig. 6. Lorenz curve and Gini Ratio of per farm and per hectare income (return above variable costs) among three rice farm types combined (LL, LO, UO), Albay, 1968-1969.

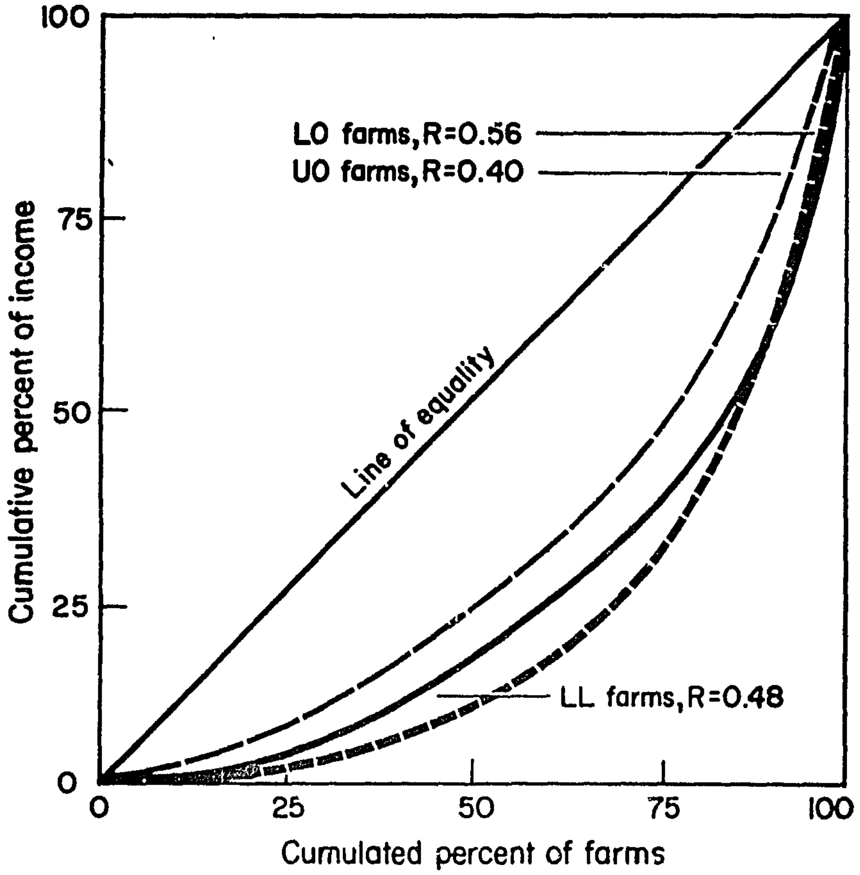

Fig. 7. Lorenz curves of income per farm (return above variable costs) by types of farm, Albay, 1968-1969.

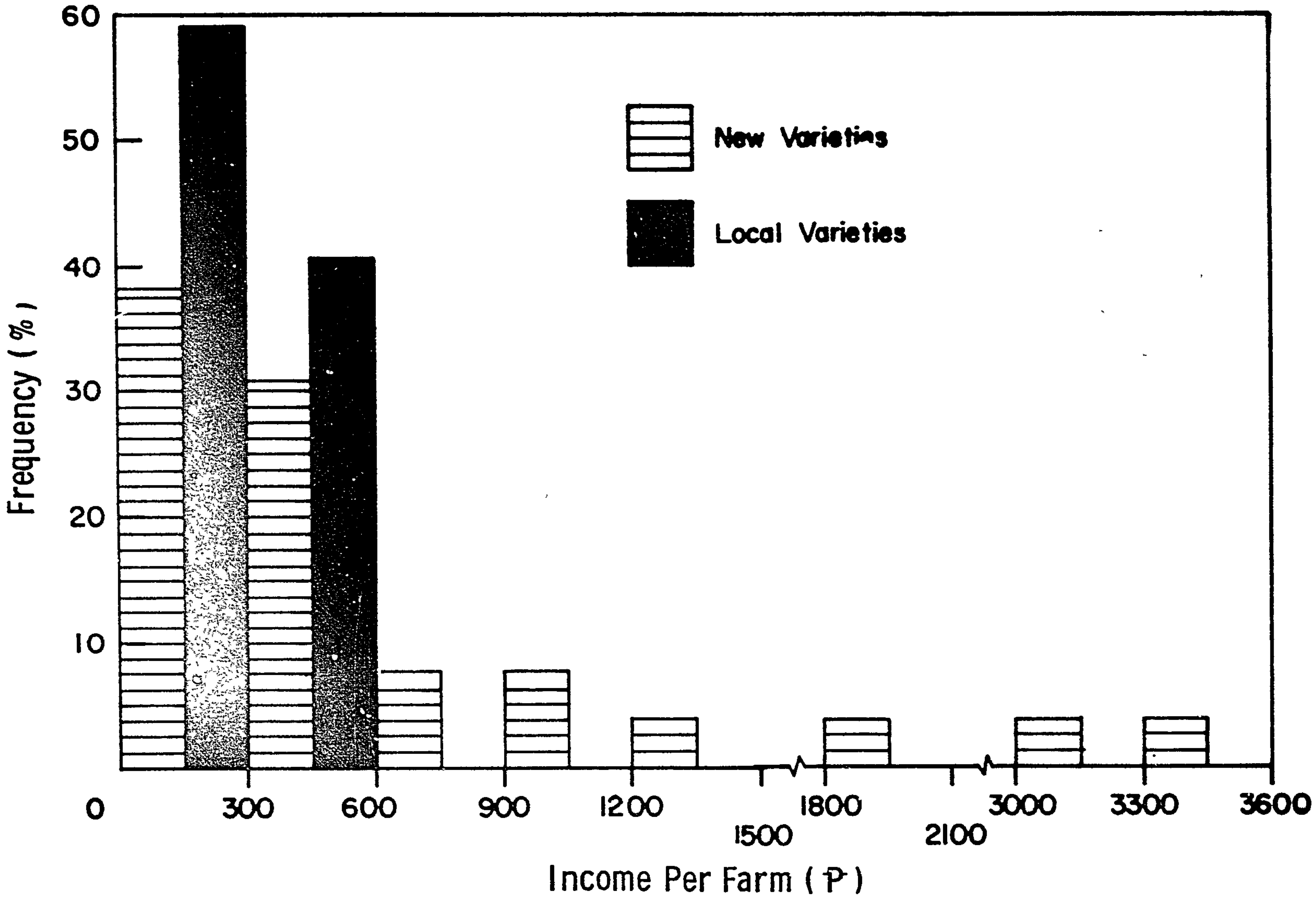

Fig. 8. **Effect of new varieties on per farm income distribution (return above variable costs)** among lowland rice farms (LL). Albay. 1st crop, 1968-1969.

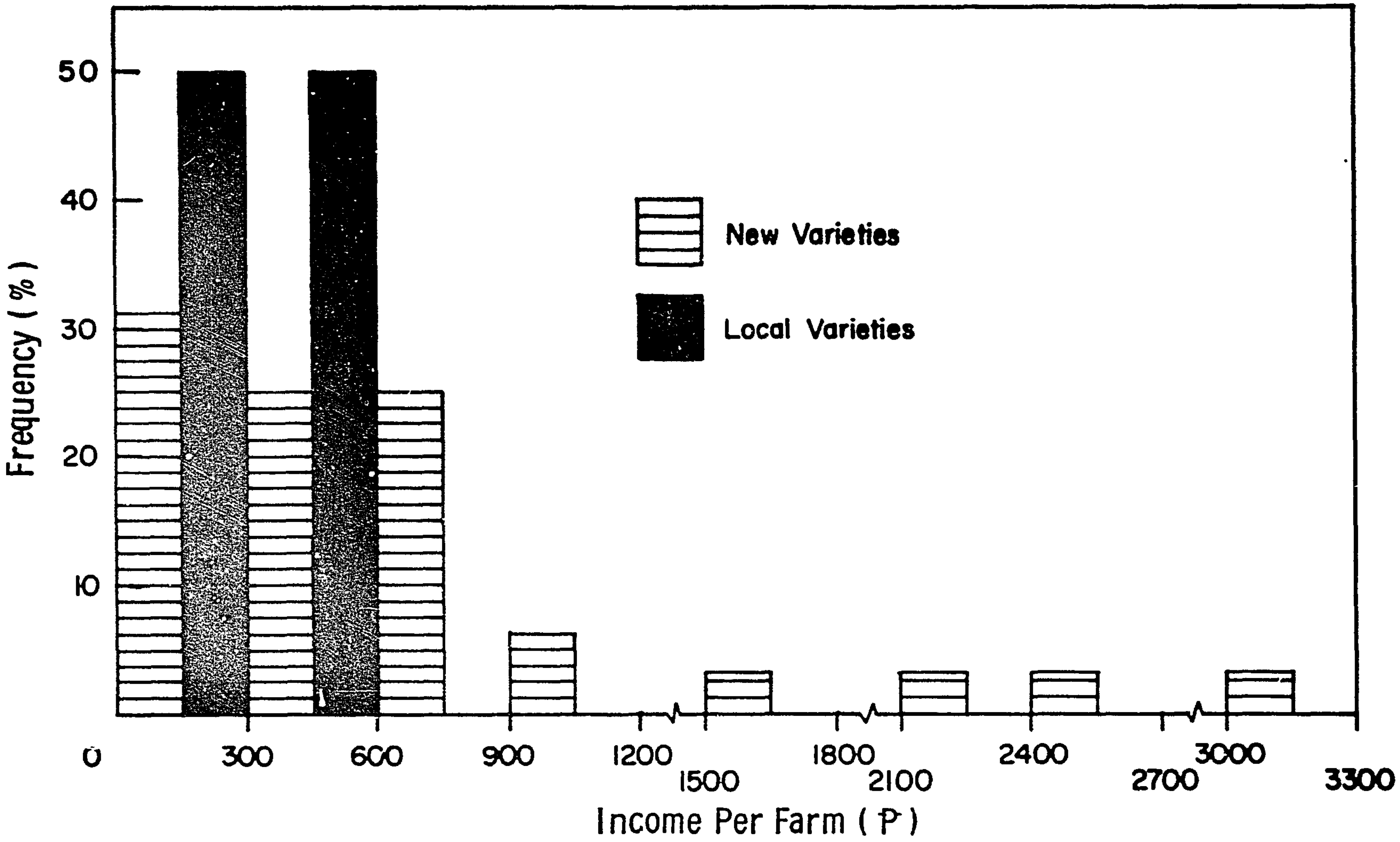

Fig. 9. Effect of new varieties on per farm income distribution (return above variable costs) among lowland rice farms (LL), Albay, 2nd crop, 1968-1969.

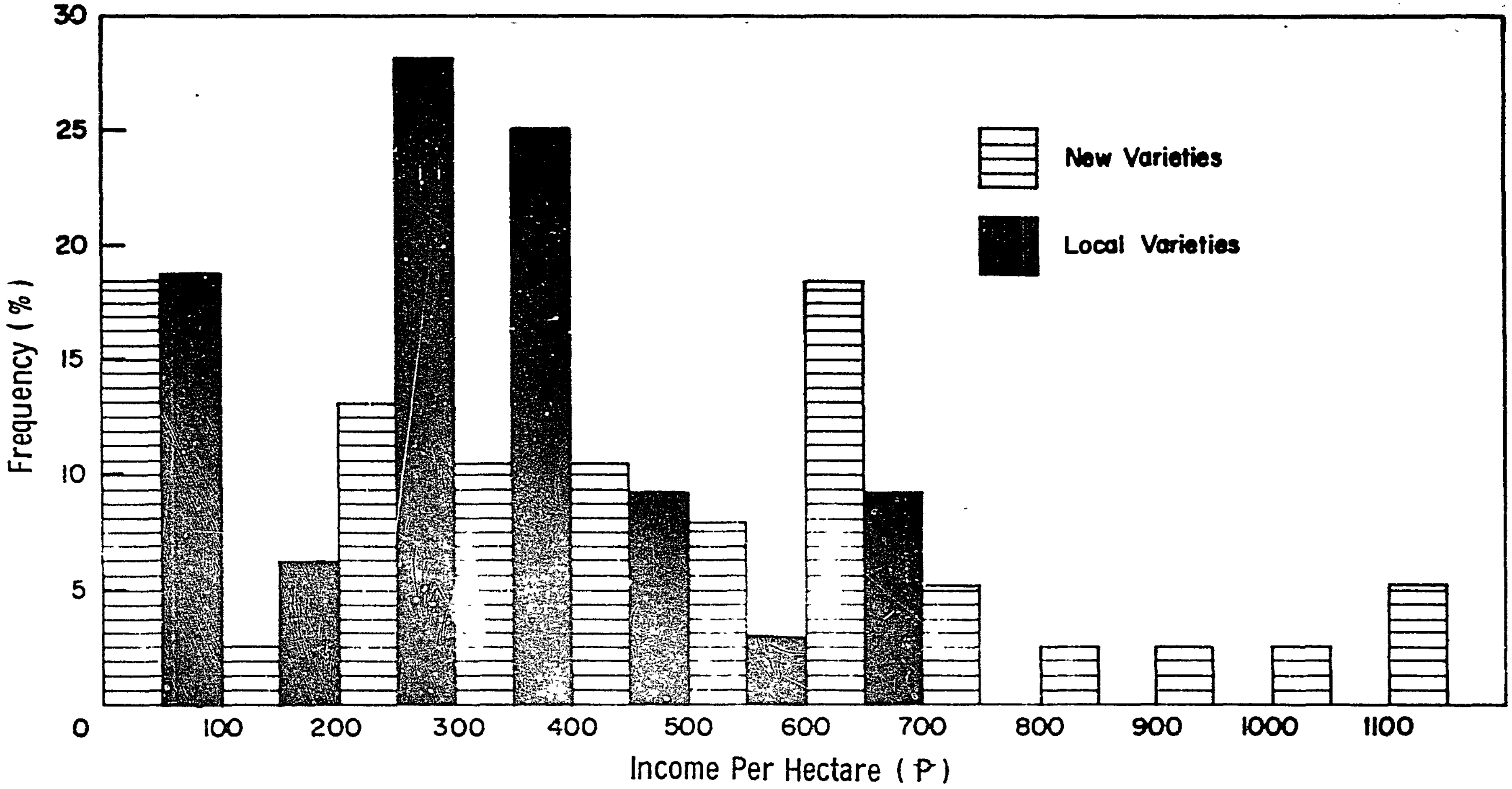

Fig. 10. Effect of new varieties on the per hectare palay income distribution pattern (return above variable costs) among lowland rice farms, Albay, 1st crop, 1968-1969.

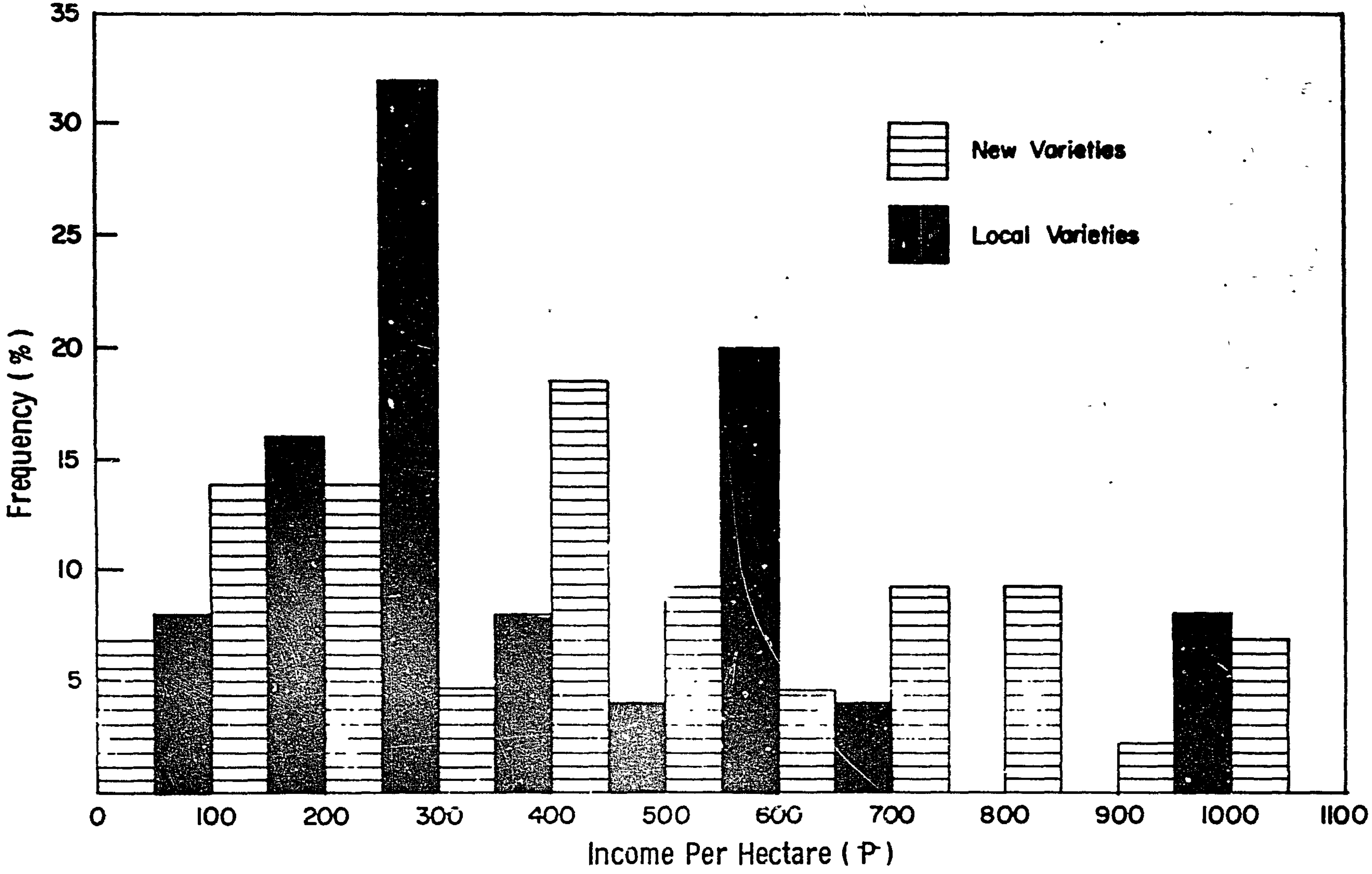

Fig. 11. Effect of new varieties on per hectare palay income distribution (return above variable costs) among lowland rice farms, Albay, 2nd crop, 1968-1969

The analysis does not provide complete proof of the impact of the high-yielding varieties because there are no records of performance of farms before they adopted new varieties.

3.5 Factors affecting income variability

Farm management studies have long established empirical evidence that financial success in farming is dependent on various interrelated factors. These factors may be grouped into two categories: (1) those that farmer can influence or within his control, e.g., farm size, capital, etc., and (2) those that he can do nothing about or hardly influence alone, e.g., weather conditions, prices, etc.

In this analysis, the variation in four factors - (1) farm size (cultivated area in hectare), (2) capital per hectare, (3) work units (labor per hectare), and (4) multiple cropping index - were compared with the variation in income. These factors are closely associated with cultivation intensity and, by and large, within the control or influence of the individual farmers. A simple tabular analysis is presented in Tables 5 through 8 for each type of farm. Each table indicates the main and related factors associated with income variability.

The following generalization may be drawn from the analysis:

(1) Income per hectare declines as the size of farm increases. No clear explanation can be drawn from the related factors for this relationship except in the case of LL farms where farm size and capital appears complementary.

(2) Capital per hectare revealed an interesting relationship with income and related factors for LO farms. As shown in Table 6, there is a consistency of capital contribution in increasing income even as farm size varies. The relationship further suggests a proportion of farm capital, multiple cropping index, and labor. For LL and UO farms, the relationship between capital and income is not clear.

(3) With the exception of LL farms, there is a consistent relationship of labor with income up to a certain extent (Table 7). Among LO and UO farms, opportunity for increasing income per hectare may be achieved through proportionate increase of labor with capital, subject to a certain lower limit of farm size.

(4) Multiple cropping index does not show direct relationship with income, as shown in Table 8. This implies that multiple cropping or crop diversification per se does not assure farmers of increased income. What appears crucial is proper choice of rotation or combination in relation to farm resources and product market. This needs a more detailed study. Another

TABLE 5. Relation of size of farm to income, by type of farm, Albay, Bicol, 1968-1969.

Farm size (ha)	No. of farms	Average related factors		Return above variable costs	
		Capital (₱/ha)	Work units (man-days/ha)	(₱/ha)	(₱/farm)
		Lowland rice (LL)			
< 1	22	1743	296	939	481
1 - 1.9	15	1314	203	673	880
2 - 2.9	4	617	138	589	1325
3 +	10	1096	192	752	2856
		Lowland rice and other crops (LO)			
< 1	7	1154	207	432	277
1 - 1.9	6	1588	235	676	902
2 - 2.9	7	1350	153	450	1061
3 +	7	731	74	331	3577
		Upland rice and other crops (UO)			
< 1	4	835	190	132	70
1 - 1.9	9	1055	85	207	268
2 - 2.9	3	443	65	127	257
3 +	7	471	61	76	351

TABLE 6. Relation of capital per hectare to income by type of farm, Albay, Bicol, 1968/69.

Capital per hectare in pesos (₱)		No. of farms	Average related factors			Return above variable costs	
Range	Mean		Cultivated area, ha.	M-C index[1]	Work units (man-days/ha)	(₱/ha)	(₱/farm)
			All-rice lowland rice farm (LL)				
< 600	434	13	1.77	-[a]	164	581	1028
600 - 1100	871	14	1.95	-	235	790	1539
1101 - 2000	1492	13	1.07	-	289	692	741
> 2000	3116	11	1.24	-	265	958	1192
			Lowland rice and other crops farm (LO)				
< 600	283	7	7.56	126	74	279	2109
600 - 1000	774	7	4.46	144	173	417	1861
1001 - 2000	1321	8	1.19	169	199	509	608
> 2000	2840	5	2.20	173	226	651	1432
			Upland rice and other crops farm (UO)				
< 300	181	8	3.31	118	59	65	217
300 - 500	407	5	2.00	140	138	151	301
501 - 900	677	5	1.48	141	87	236	348
> 900	1840	5	1.64	128	112	107	175

[1] M-C index = $\frac{\text{effective crop area}}{\text{cultivated area}}$ x 100.

[a] M-C index is approximately constant for this farm type.

TABLE 7. Relation of work units to income, by types of farm, Albay, Bicol, 1968/69.

Work units per hectare		No. of	Average related factors			Return above variable costs	
Range	Mean	farms	Cultivated area, ha.	M-C index[1]	Capital ₱/ha	(₱/ha)	(₱/farm)
			All rice lowland rice farm (LL)				
< 160	120	13	1.80	-	1176	652	1175
160 - 220	192	16	1.66	-	1291	609	1013
221 - 260	241	13	1.63	-	1231	1018	1664
> 260	472	9	0.73	-	2171	689	504
			Lowland rice and other crops farm (LO)				
< 100	60	8	8.52	114	784	205	1749
100 - 150	127	8	2.56	159	1313	637	1632
151 - 250	214	7	1.61	166	1316	842	1352
> 250	363	4	1.20	192	1545	688	827
			Upland rice and other crops farm (UO)				
< 50	38	8	3.65	117	1025	68	247
50 - 90	71	6	1.79	125	426	158	282
91 - 130	113	5	1.98	122	502	189	374
> 130	214	4	0.56	175	700	186	105

[1] M-C index = $\frac{\text{effective crop area}}{\text{cultivated area}} \times 100$

TABLE 8. Relation of multiple cropping index to income by type of farm, Albay, Bicol, 1968/69.

Multiple cropping index		No. of farms	Average related factors			Return above variable costs	
Range	Mean		Cultivated area (ha.)	Capital ₱/ha	Work units (man-days/ha)	(₱/ha)	(₱/farm)
			Lowland rice and other crops farm (LO)				
< 120	103	8	8.25	875	82	177	1459
120 - 170	147	8	3.02	894	132	765	2311
171 - 199	182	6	1.49	1027	209	430	640
> 200	205	5	1.13	2371	296	1034	1163
			Upland rice and other crops farm (UO)				
< 110	100	11	2.51	509	85	113	283
110 - 140	125	5	1.97	1416	67	145	287
141 - 190	155	3	3.69	333	70	54	199
> 190	200	4	0.90	597	167	203	178

inference that can be drawn from the analysis in Table 8 is that labor and capital cannot substitute for each other to a greater extent without affecting the level of income under multi-crop farms.

4.0 SUMMARY AND IMPLICATIONS

(1) Typical types of rice farms in Albay province may be described as: all lowland rice farms, lowland rice and other crops, and upland rice and other crops.

(2) Of the three types of farms studied in Albay, Bicol, upland rice farm is the least productive; upland farm income is about one-fifth that of lowland farms.

(3) Per farm total income distribution between and within farm types in the study area is positively skewed, indicating that more farmers are in the lower levels of the income distribution. This was found to be largely due to the difference in type and size of farms.

(4) Per hectare income distribution varies less widely than per farm. But the use of per hectare distribution may just obscure the true welfare conditions of farmers since size of farms varies greatly even for a given type and in a given region.

(5) The new rice varieties may have affected the income distribution per farm. Even on the per hectare basis, more farmers able to adopt new varieties are in the advantageous side of the income scale. This finding lends some support to the widely held hypothesis that the new varieties will tend to widen the income distribution. If this is true, then the relevant question is to what extent, and what are the alternatives open to those not able to benefit from the rice technology? The question needs further investigation.

(6) Some interesting relationships were revealed from the exploratory analysis of selected factors affecting income. But this type of analysis in the sense of two variable functional relationships cannot be a dependable basis in predicting incomes. The total effect of different combinations of factors can be specified by actually working out the multiple relationships between each combination of factors and incomes.

THE PHILIPPINE FERTILIZER INDUSTRY: GROWTH AND CHANGE

Randolph Barker[1]

1.0 INTRODUCTION

The introduction of the new, high yielding varieties of rice in the Philippines increased the demand for fertilizer. The domestic fertilizer industry responded by expanding its capacity and its local distribution network, making it possible for essentially all commercial rice farmers to obtain the amount of fertilizer desired. In spite of these developments, only one of the four major fertilizer plants made a profit in 1968. This paper describes the growth of the fertilizer production and distribution system and discusses the difficulties currently encountered by the local industry.

2.0 GROWTH OF IMPORTS AND DOMESTIC PRODUCTION

Since 1950 the chemical fertilizer consumption of the Philippines has been growing at an annual rate of about 9 percent based on the quantity of fertilizer imported and produced locally (Fig. 1). This rate understates the true growth since the composition of fertilizer has changed over the period. In 1950 the bulk of the fertilizer was ammonium sulfate. At present, mixed fertilizers and urea make up a considerable share of the total. The nutrient content of a ton of fertilizer may have increased by as much as 30 percent. This would indicate a growth of about 10 percent over the 17-year period based on nutrients consumed.

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[1] Agricultural Economist, International Rice Research Institute. The author would like to acknowledge the contribution of Hilda C. Hamoy, Violeta G. Cordova, and Wilfredo M. Maldia who were responsible for the collection of most of the data.

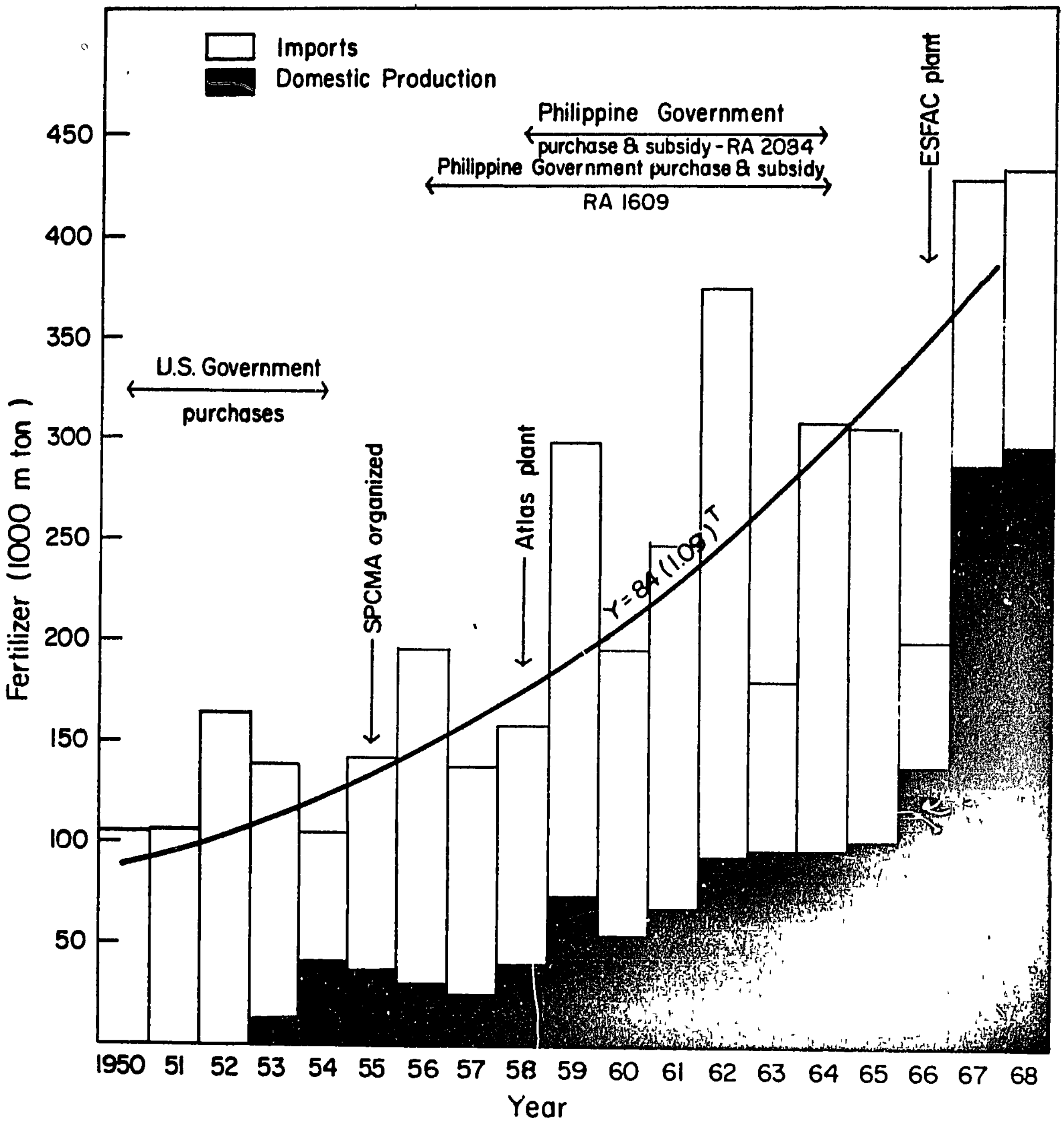

Fig. 1. Total imports plus domestic production of inorganic fertilizer, Philippines, 1950-1968.

2.1 Government activity

From the period 1950 to 1954, US $10 million worth of fertilizer was imported under the Economic and Technical Cooperation Agreement between the Philippines and the United States governments. Importation declined in 1954, but increased in the following year with the beginning of imports by the Sugar Producers Cooperative and Marketing Association (SPCMA).

Under Republic Act 1609 (See Appendix Tables 2 and 3), the Agricultural Credit Administration (ACA, then the ACCFA) appropriated ₱45,513 thousand for the purchase and distribution of fertilizer over a period of seven crop years (1956/57 to 1962/63). Purchases were made principally from domestic producers and distributed at subsidized prices through the farmers' cooperatives. The subsidy represented more than 50 percent of the commercial retail price.

Republic Act 2084 provided for the distribution of fertilizer specifically to rice and corn farmers at a 50 percent subsidy. Between 1958/59 and 1963/64 a total of ₱44,541 thousand worth of fertilizer was distributed under this program. However, it is estimated that more than 50 percent of the fertilizer intended for rice and corn producers was diverted or resold for use on sugarcane or other crops. Another difficulty with the program was the disproportionate acquisition of mixed vs nitrogenous fertilizers relative to local farm demand.

In 1964 the ACA terminated its fertilizer subsidy program, but it continues to sell fertilizer through cooperatives at rates slightly below the current commercial level. The passage of Republic Act 3050 in June 1961 removed import duties on fertilizer for farmers' cooperatives. This tariff, which amounts to 20 percent of the C&F value (cost plus freight to the Philippines), was reinstated for cooperatives in 1965, but imports by cooperatives are currently exempted from the 7 percent advanced sales tax required of all private importation and domestic production.

2.2 Domestic production

The fertilizer industry in the Philippines is at present composed of four inorganic fertilizer plants, three organic plants, and several small importer-compounder plants. The four inorganic plants which make up 90 percent of total fertilizer production, are shown in Table 1 together with rated capacities and actual production for the three-year period 1966 to 1968. There is some question as to whether the listed capacity can actually be achieved. Some observers would place the present production capability of the industry well below the capacities shown.

The first of the local plants to begin operation, the Maria Cristina, was operated under the National Power Corporation from 1951 until 1960 at which time it was purchased by the Marcelo Steel Corporation. The initial domestic production was oriented toward the demands of the sugar industry. A 1964 survey by the Market Research Division of the San Miguel Corporation (See Appendix Table 4) showed that 144,000 metric tons of fertilizer or 49 percent of the fertilizer was being used on the approximately 300,000 hectares of sugarcane land while 79,000 metric tons or 27 percent of consumption was being used on 3 million hectares of rice. Of course, most of this hectarage planted to rice received no fertilizer.

TABLE 1. Capacity and actual production of the four domestic fertilizer plants, Philippines, 1966 to 1968.

Manufacturer	Type of fertilizer	1966 Capacity	1966 Actual	1967 Capacity	1967 Actual	1968 Capacity	1968 Actual
Esso Standard Fertilizer and Agricultural Chemical Co., Inc. (Phils.) (1966)	Urea	60,000	3,000	60,000	25,000	60,000	17,948
	Complex Fertilizer	165,000	14,000	165,000	36,000	165,000	121,798
	Mixed Fertilizer	165,000	19,703	165,000	38,701	165,000	
	Total	390,000	36,703	390,000	99,701	390,000	139,746
Atlas Fertilizer Corporation (1958)	Ammonium Sulphate	70,000	10,532	70,000	34,000	70,000	29,004
	Complex Fertilizer	65,000	26,580	65,000	36,800	65,000	50,457
	Superphosphate	27,000	-	27,000	-	27,000	-
	Total	162,000	37,082	162,000	70,800	162,000	79,461
Ma. Cristina Fertilizer Corporation (1960)	Ammonium Sulphate	50,000	24,947	50,000	40,426	50,000	6,582*
	Aqua Ammonia	-	-	36,624	8,447	36,624	
	Total	50,000	24,947	86,624	48,873	86,624	6,582
Chemical Industries of the Philippines, Inc. (1960)	Ammonium Sulphate	30,000	7,000	54,000	6,000	54,000	8,000
	Complex Fertilizer	12,000	6,000	12,000	5,000	12,000	8,000
	Superphosphate	15,000	2,400	15,000	1,000	15,000	2,000
	Total	57,000	15,400	81,000	12,000	81,000	18,000
	Grand total	659,000	113,132	719,624	231,374	719,624	243,789

Source: Fertilizer Institute of the Philippines, Inc.

* Production stopped due to prolong labor strike.

In spite of government activities, which were sometimes in conflict with the development of private local production and distribution, the domestic fertilizer industry continued to grow. However, until recently, the Philippine government has been the main supplier of fertilizer to the rice industry. A major shift came with the end of the government subsidy program in 1964 and the opening of the ESFAC plant in mid-1966. The latter event coincided fortuitously with the initial Institute release of 50 tons of IR8 seed to the Philippine government.

In 1968 the domestic production of 244 thousand metric tons represented more than one-half of total production plus imports, but this was less than 50 percent of rated domestic plant capacity. The low utilization of domestic capacity appeared to be due to: (1) continued competition from direct imports particularly in the sugar industry, (2) difficulties relating to plant operation, and (3) the failure of plant capacity to match, product by product, local demand.

3.0 THE DISTRIBUTION SYSTEM

The fertilizer distribution system in the Philippines can be characterized only by describing the way in which fertilizer is transferred from the company to the farmer. The methods employed by each company and by the government differ considerably.

For the first three companies to enter the fertilizer business - Maria Cristina, Chemphil, and Atlas - the relationship between the company and the farmer has been passive. Fertilizer is sold by the company to distributors or outlets; beyond this point the company has no direct interest. Distributors may in turn sell their fertilizer to retail dealers of their own choosing who in turn sell to farmers. Consider, for example, the system employed by Atlas. It delivers fertilizer to its 14 regional distributors located throughout the Philippines. The regional distributors in turn select their dealers, who are for the most part store owners engaged in selling a wide range of other products. There are about 500 retail stores handling Atlas fertilizer products (Table 2).

The system adopted by ESFAC is based upon a more direct relationship among Company, retail dealer, and farmer. A dealer is selected by the company and undergoes six months of training in the technical aspects of fertilizer use, and in business management and salesmanship. At the end of the training period he is awarded a one-year contract to sell only ESFAC products, and is referred to as an Agroservice dealer. There were more than 400 such dealers in the Philippines in 1968 (Table 2). The company employs a trade name for its products, ENGRO, and carries on aggressive nationwide sales and advertising campaign to encourage farmers to use more fertilizer in general and its product in particular.

The ACA has 155 local warehouses. About 130 district fertilizer agents serve as liaison officers between the farmers' cooperatives (FACOMAS) and the district warehouses. However, because of the lack of field personnel, the district farmer agents are more often salesmen than liaison officers. Each is assigned a number of towns. Where there are no active farmers' cooperatives, outlets are designated by the ACA branch office. Fertilizer stocks are normally kept in warehouses of the no longer active cooperatives and assigned for distribution during certain days of the week.

TABLE 2. Distribution of domestic fertilizer dealers by region and company, Philippines, 1968.*

Region	ESFAC	Atlas	Ma. Cristina	Chemphil	ACA	Total
Ilocos	23	35	31	11	7	107
Cagayan	32	13	13	20	6	84
Central Luzon	89	123	103	15	44	374
Southern Tagalog	61	75	99	9	19	263
Bicol	36	33	6	-	5	80
E. Visayas	24	86	4	-	11	125
W. Visayas	47	32	14	2	11	106
N & E Mindanao	38	36	11	1	12	98
S & W Mindanao	53	71	24	2	15	165
Total	403	504	305	60	130	1,402

Total private fertilizer dealers: 1,272

Total ACA district fertilizer agents: 130

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* Source of basic data: Fertilizer Institute of the Philippines.

In order to learn more about the distribution system, two surveys were conducted of retail dealers and outlets. The first survey, undertaken in the latter part of 1968, involved 122 retail dealers in 12 major rice growing provinces. This number represented a 20 percent sample of all dealers. The second survey, conducted in early 1969, included a complete enumeration of all dealers in Laguna Province.

3.1 Survey of dealers in 12 provinces

The 12 rice-producing provinces selected for the survey included: Bulacan, Pampanga, Nueva Ecija, Pangasinan, and Tarlac in Central Luzon; Laguna in the Southern Tagalog region; Albay in Bicol; Ilocos Sur and Cagayan in Northern Luzon, Iloilo and Leyte in the Visayas; and Cotabato in Mindanao.

Based on the survey, a chart (Fig. 2) was drawn to indicate the rate of growth of the retail fertilizer outlets in the major rice-producing areas. There was no evidence to show that growth had been more rapid in any particular region, thus, all provinces are combined in the graph. In developing the chart, the survey was weighted to adjust for the fact that the sample did not reflect accurately the percentage of dealers represented by a given company in a given province. This adjustment was essential because the time at which a company dealer began to sell fertilizer was closely related to the start-up date of the company's fertilizer plant. Thus, one can observe an increase in the number of retail outlets after 1958 with the opening of the Atlas Fertilizer plant, and an even greater increase from 1966 with the opening of the ESFAC plant.

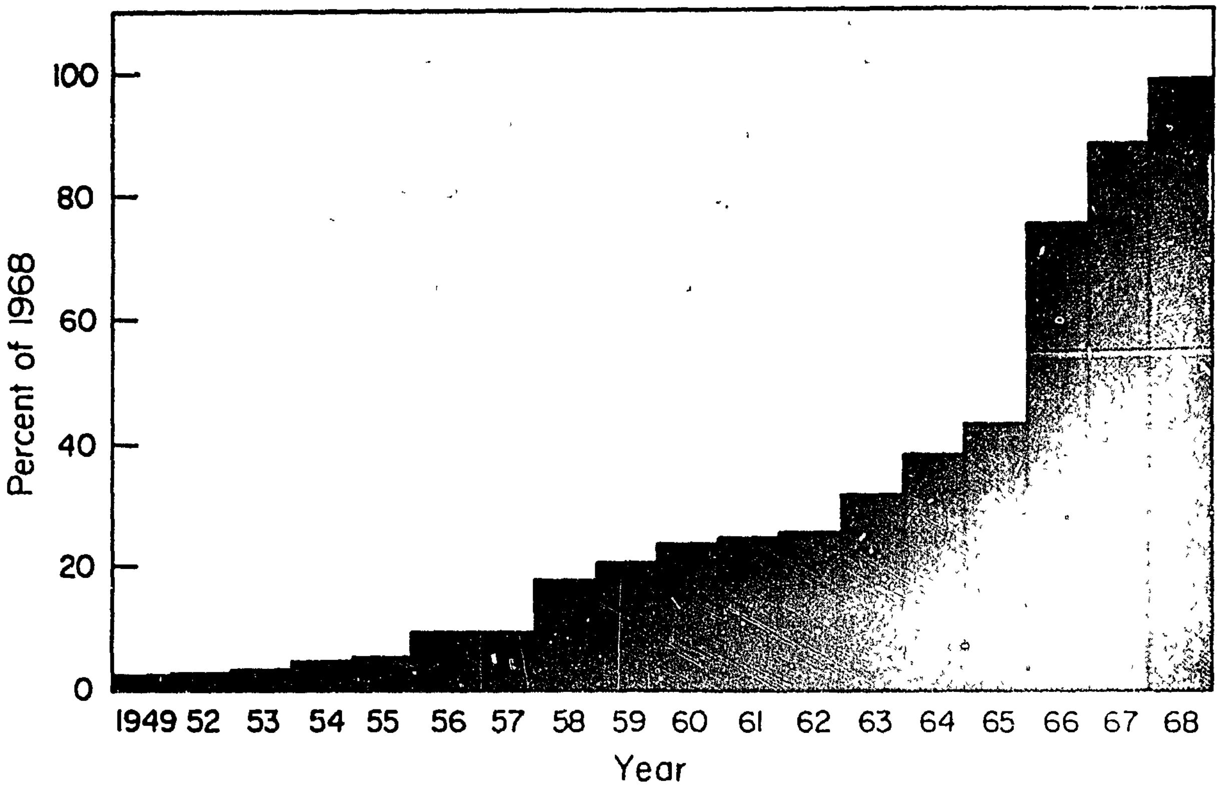

Fig. 2. Growth of fertilizer dealers in 12 major rice producing provinces, Philippines, 1949 to 1968.

The figure is only a rough approximation of the situation since there have been many unrecorded changes. Many dealers have gone out of business; others started selling, stopped temporarily, then started selling again. Of the original sample drawn, 13 percent were not operating at the time of the interview, 6 percent were non-existent, and 4 percent had never been fertilizer dealers.

The majority of the dealers provide credit to a selected number of their customers although the fertilizer companies themselves do not extend credit to the dealers. The ESFAC dealers in particular do soil testing and to a lesser extent run demonstration farms. Nearly all dealers make recommendations on the type and amount of fertilizer to apply. The majority also make recommendations on time of application. The source of information or basis for these recommendations varies, but the most important is the company itself through company publications and technical fertilizer recommendations. Apparently, dealers rely very little on extension workers for information.

The price per bag of fertilizer paid by farmers, as reported by the dealers interviewed, is shown in Table 3. The price is highest in those areas with the longest overland haul, Cagayan and Albay. It is lowest for ammonium sulfate and urea in Pampanga, which is a major sugar producing area in Central Luzon. Some of the fertilizer purchased through the sugar cooperatives undoubtedly finds its way to rice paddies. Farmers pay about one-third more per kilogram of elemental nitrogen in the form of ammonium sulfate vs urea.

TABLE 3. Average price per bag paid by farmers for fertilizer purchased from private and government sources in 12 leading rice provinces, Philippines, 1968. [a/]

	Ammonium Sulfate	Urea	12-12-12
	(₱)	(₱)	(₱)
Central Luzon			
Bulacan	13.80	24.40	16.20
Pampanga	12.00	21.90	17.00
Nueva Ecija	13.50	23.80	17.15
Tarlac	14.90	23.90	17.50
Pangasinan	14.10	24.45	17.25
Other			
Laguna	13.80	24.40	18.50
Cagayan	16.50	27.50	22.50
Ilocos Sur	14.40	25.16	20.75
Albay	16.50	26.50	18.25
Iloilo	13.20	22.50	17.00
Leyte	15.00	23.25	19.00
Cotabato	15.30	26.60	19.00
Government[b/]			
ACA	12.50	-	15.00

[a/] All types of fertilizers are in 45 kg bags except urea which has 50 kg.

[b/] Government prices are uniform throughout.

3.2 Survey of Laguna dealers

A complete enumeration of fertilizer dealers in Laguna was made in 1969 to provide more details concerning the distribution system in a single province.[2/] There were 34 dealers serving the province (which excludes the sugar cooperatives who supply fertilizer to their members). These 34 dealers served an estimated 6,345 buyers in 1967 and 1968, approximately 80 percent of whom were growing rice. Thus, on the average, one dealer served about 185 buyers (but indirectly a larger number of farm operators since landowners frequently buy fertilizer for their tenants).

The volume of business, however, varied considerably between dealers as illustrated in Table 4. In this table, firms have been divided into three groups by size. The large dealers, 15 of the 34, account for more than 90 percent of the sales volume. Not all of the fertilizer was sold directly to the farm. In many instances, smaller dealers purchased supplies from larger dealers.

The breakdown of sales by type of fertilizer is shown in Table 5. Laguna rice farmers show a strong preference for nitrogenous fertilizers. Sales of ammonium sulfate exceed urea. Approximately two-thirds of the ammonium sulfate was imported and sold by the German based firm Rustica. ESFAC was the major seller of urea.

[2/] For a more detailed discussion of the Laguna survey, see Wilfredo C. Maldia, Pattern of Purchase and Distribution of Fertilizer by Dealers in Laguna, 1967-68. Unpublished Master's thesis, University of the Philippines College of Agriculture, 1969.

TABLE 4. Volume of fertilizer sold per year by type and by size of business, 34 dealers, Laguna, 1967-68.

Size	No. dealers	Average employees per firm	Type of fertilizer Ammonium Sulfate	Urea	Complete mix	All types
				(Pesos)		
Small (below ₱10,000)	10	1.6	24,960	15,969	5,493	46,422
Medium (₱10,000 to ₱20,000)	9	2.4	105,450	54,090	7,712	167,252
Large (₱20,000 above)	15	3.0	1,007,387	1,145,133	266,408	2,488,928
All dealers	34		1,207,797	1,215,192	279,613	2,702,602

TABLE 5. Quantity of fertilizer procured by type, 34 dealers, Laguna, 1967-68.

Source	Type of fertilizer [a/] Ammonium Sulfate	Urea	Complete mix	Total
		(bags)		
Domestic[b/]	30,080	29,450	9,556	69,086
Imported	57,000	21,820	650	79,470
Total	87,080	51,270	10,206	148,556

[a/] One bag of Urea normally weighs 50 kg. while one bag of other type weighs 45 kg.

[b/] Sales of ESFAC are defined as domestic, although the company was both importing and producing fertilizer locally during this period.

Taking into account the sales between dealers, and the sales to non-rice farmers, perhaps 100 thousand bags of fertilizer were used on the 32,000 thousand crop hectares of rice in Laguna. This would represent approximately 3 bags of fertilizer per hectare or 45 kilograms actual nitrogen per hectare per crop.

The procurement and sales price for fertilizer is shown by size of firm and by type of fertilizer in Table 6. There is approximately a 10 percent mark-up for dealer services and profit. The large firms purchase and sell fertilizer at about 5 percent less than the small firms.

4.0 PROBLEMS CONFRONTING THE INDUSTRY

In spite of the rapid growth of the industry and the favorable outlook for fertilizer demand, the current situation cannot be described as "healthy". The situation can best be understood by examining the way in which fertilizer is priced.

4.1 Pricing of fertilizer

The domestic price of fertilizer is related to the import cost. The example below indicates how the import cost is calculated for ammonium sulfate and urea delivered to the Philippines from Japan at approximately US $45 and US $75 per metric ton (C&F), respectively:

TABLE 6. Average procurement and sale price by size of firm and type of fertilizer, 34 dealers, Laguna, 1967-1968.

Size	No. dealers	Type of fertilizer Ammonium Sulfate	Urea	Complete mix
			(Pesos)	
Small (below ₱10,000)	10			
Procurement		13.25	22.39	21.66
Sales		14.47	24.38	24.10
Medium (₱10,000 to ₱20,000)	9			
Procurement		13.00	22.01	19.68
Sales		14.25	24.04	21.66
Large (₱2,000 above)	15			
Procurement		12.71	21.64	19.63
Sales		13.81	23.65	21.46
All dealers	34			
Procurement		12.99	21.90	19.82
Sales		14.18	23.90	21.81

	Imported fertilizer	
	Ammonium Sulfate	Urea
C&F value per metric ton	₱175.50	₱292.50
duty	35.10	14.60
other charges	17.50	17.50
advanced sales tax	16.00	22.70
Landed port	₱244.10	₱347.30
Price per bag at port for cooperative	₱ 10.25	₱ 16.25
Price per bag at port for private importer	₱ 11.00	₱ 17.35

The duty is 20 percent for ammonium sulfate and 5 percent for urea. The advanced sales tax of 7 percent need not be paid if the fertilizer is imported and sold through the cooperatives. However, domestic producers must pay an advance sales tax on all sales, putting them at a relative disadvantage in making sales to cooperatives.

The difference between price landed port and the retail price offered by the dealer, as shown in Tables 2 and 5, represents the cost of transportation to the warehouse, warehousing, transportation to the dealer, and profit mark-ups. In Nueva Ecija, for example, averaging urea and ammonium sulfate, the total mark-up from port to dealer would represent 23 percent of dealer price, whereas, in the more remote Cagayan Valley the mark-up would represent about 35 percent of the dealer price.

It is not possible to determine the profit margins of local producers. However, only the Atlas Fertilizer Company showed a profit in 1968 while ESFAC showed substantial losses. The local industry complains that it is burdened by under-protection, and is harassed by unfair competition and in some cases "dumping" of fertilizer by foreign firms. Why does this occur?

4.2 Economies of size

Unlike the production of many farm crops, the production of fertilizer requires the use of inputs which are not divisible. Whether in advanced or in developing countries, cheap fertilizer is produced in large plants which can take advantage of substantial economies of size. Most developing countries do not have the initial local demand for fertilizer to warrant the construction of large scale plants. Over the short run, plants of smaller capacity are frequently constructed in line with the policy objective of creating a local industry. The economies of size, however, continue to point in the direction of concentration of world fertilizer production in large plants. This is particularly true for nitrogen, the most important fertilizer element for Philippine agriculture. The development of the revolutionary new Kellogg method of producing ammonia in 1965 made it possible to nearly cut in half the cost by more than trippling the plant size from 300 to 1,000 tons of ammonia per day.

4.3 Recent developments

Partly as a consequence of new technological developments, world supply of fertilizer has been growing somewhat more rapidly than world demand in the last few years. As a result, major world exporters such as Japan, Europe, and the United States have found stiff competition in international trade. To capture markets, they have sometimes found it necessary to lower export prices covering only operating costs. However, there is no sign that this "unfair competition" or "dumping" will abate in the near future.

Given the industry structure that exists in the Philippines, where three of the four local plants must be considered small by international standards, there are three alternatives for the future:

(1) maintain the local industry by the continuance or perhaps even the eventual increase of the current tariff levels.

(2) allow competition from imports to force up costs and erode the profit margins of local plants, and eventually force closure.

(3) follow step (1) above but subsidize the price of fertilizer to farmers.

None of these alternatives are palatable. It is largely a matter of deciding who should bear the cost.

In spite of this rather gloomy outlook for the local industry, it is surprising to find consideration being given to the construction of two new plants, one by the Marcelo industrial group, which now operates the Maria Cristina plant, and a second by the sugar producers cooperatives.

5.0 CONCLUSIONS

The fertilizer industry of the Philippines has undergone a dramatic change in the past decade. Fertilizer production and distribution started as a government monopoly, but has gradually shifted to the private sector. Private sector sales were at first concentrated on the sugar industry but have now spread to rice and corn aided by the development of new fertilizer responsive varieties. The aggresive sales policy of companies such as ESFAC and Rustica has added a new dimension to the industry.

The growth of the domestic industry raises some interesting questions regarding the future structure of the industry. Farmers have benefitted from the industry's development of the local distribution system. Considering the services provided and the cost of transportation and marketing, farm fertilizer prices are currently well in line with those of other Asian countries. At the same time, it may be difficult for Philippine farmers to benefit from recent technological advances in fertilizer manufacture which will mean cheaper fertilizer for farmers in many parts of the world. Further expansion of the domestic industry would almost certainly have to be accompanied by higher protective tariffs.

APPENDIX TABLE 1. Total available supply of inorganic fertilizer, 1950-1968 (in metric tons).

Year (1)	Total supply (2)	Importation (3)	% of total (4)	Local production (5)	% of total (6)
1950	106,803	106,803	100.0	-	-
1951	108,279	108,279	100.0	-	-
1952	168,506	168,506	100.0	-	-
1953	147,923	139,452	94.3	8,471	5.7
1954	104,604	70,077	67.0	34,527	33.0
1955	141,354	108,682	76.9	32,672	23.1
1956	95,439	69,056	72.4	26,383	27.6
1957	191,960	160,958	83.8	31,002	16.2
1958	159,195	119,306	74.9	39,889	25.1
1959	297,718	223,638	75.1	74,080	24.9
1960	200,612	145,867	72.7	54,745	27.3
1961	253,208	185,589	73.3	67,619	26.7
1962	409,420	317,589	77.6	91,831	22.4
1963	188,129	95,674	50.9	92,455	49.1
1964	321,405	224,233	69.8	97,172	30.2
1965	342,625	242,413	70.8	100,212	29.2
1966	230,737	116,605	50.5	114,132	49.5
1967	421,864	190,490	45.2	231,374	54.8
1968	464,216	220,427	47.5	243,789*	52.5

Source: Fertilizer Institute of the Philippines excluding 1953-1957 production figures provided by Rafael Paguio of the Marcelo Steel Corporation, and 1958-1959 production by Central Bank.

* Maria Cristina's normal production is 50,000 M. T. but the 8-month labor strike upset its production.

APPENDIX TABLE 2. Fertilizer procured and distributed under RA 1609 (in thousand).

Fiscal Year	Fertilizer procured		Fertilizer distributed		No. of ha. fertilizer	No. of farmers served
	Bags	Metric tons	Bags	Metric tons		
1956-57	-	-	-	-	-	-
1957-58	2,314	105	1,973	89	393	131
1958-59	-	-	134	6	27	9
1959-60	389	18	313	14	62	21
1960-61	-	-	52	2	10	3
1961-62	1,279	58	381	17	112	54
1962-63	679	31	1,066	48	279	152
1963-64	-	-	392	18	78	26
Total	4,661	212	4,319	194	961	396

Source: Agricultural Credit Administration.

APPENDIX TABLE 3. Appropriation and actual fund releases under RA 1609 and RA 2084 (in 1000 pesos).

Year	RA 1609		RA 2084	
	Appropriation	Fund releases	Appropriation	Fund releases
1956-57	20,000	5,000		
1957-58	"	10,300		
1958-59	"	7,547	13,000	11,094
1959-60	"	-	"	11,229
1960-61	"	4,750	"	6,947
1961-62	"	11,916	"	4,050
1962-63	-	3,000	12,600	8,460
1963-64	-	-	17,600	2,751
Total	120,000	42,513	82,200	44,541

Source: Agricultural Credit Administration.

APPENDIX TABLE 4. Breakdown of 1964 fertilizer consumption by area and by crop.

Region	Sugarcane	Rice	Corn	Tobacco	Vege-tables	Pine-apple	Citrus	Other crops	All crops total	%
				(in metric tons)						
Ilocos	63	7,921	376	6,585	5,063	-	-	2,463	22,471	7.6
Cagayan Valley	-	3,731	68	337	25	-	-	86	4,247	1.4
Central Luzon	12,507	24,042	237	461	2,028	-	-	319	39,594	13.5
Southern Tagalog	7,102	12,726	4,494	1	325	398	8,452	449	33,857	11.5
Bicol	-	851	13	-	67	-	232	216	1,379	0.5
Western Visayas	106,926	14,175	337	-	3	-	279	5,255	126,975	43.1
S & W Mindanao	-	2,979	397	-	63	-	214	6,248	9,901	3.4
Eastern Visayas	17,404	3,922	284	23	2,963	-	-	2,259	26,855	9.1
N & E Mindanao	65	9,016	7,707	-	122	7,000	71	5,027	29,008	9.9
Total: Philippines	143,977	79,363	13,913	7,407	10,659	7,398	9,248	22,322	294,287	100.0
% of total	49.0	27.0	4.7	2.5	3.6	2.5	3.1	7.6	100.0	

Source: San Miguel Corporation, Market Research Department.

PUMP IRRIGATION IN LAGUNA, BATANGAS AND QUEZON, 1967-1968

Zenaida F. Toquero [1]

1.0 INTRODUCTION

1.1 Importance of the study

Pump irrigation systems are being installed in many different areas of the Philippines. Creeks are being tapped, deep wells sunk and both shallow tubewells and open wells are expanding in number.

Does pump irrigation pay? Even without studying the economics of pump irrigation in detail one might be inclined to hazard a guess that it must pay, otherwise the demand for irrigation pumps would be much weaker than is evident.

In answering most questions relating economics and agriculture, however, generalizations are hazardous. The field of pump irrigation is no exception. A definitive answer to the question posed above implies a prior set of answers to a series of questions each of which affects the income earning potential of pump irrigation. In brief, some of these are:

What yields can be expected under pump irrigation?

What is the productivity of other inputs used in conjunction with irrigation water?

How large an investment is necessary and how wide an area can be served by the resulting installation?

Will the discharge from the well remain constant over the season or will it fluctuate?

What effects does the incidence of pests and diseases have on potential returns from pump irrigation?

Even where answers to these questions are available, they cannot be applied over an entire area. The pattern of answers will vary between localities and among farms in the same locality.

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[1] Research Assistant, Department of Agricultural Economics, U.P. College of Agriculture.

1.2 Objectives of the study

This study aims to:

a) determine the initial investment, operating and maintenance cost of the pump irrigation system

b) study the farm management practices and experiences of farmers using pumps

c) study the problems involved in maintaining a system and learn about any condition which may prevent farmers from utilizing their land and water resources to the fullest extent; and

d) determine the profitability of palay production in pump irrigated farms by analyzing the costs and returns involved.

2.0 METHODOLOGY

This study was conducted in crop year 1967/68 in three northwestern towns of Laguna, namely: Cabuyao, Sta. Rosa and Biñan, and in San Juan, Batangas and Sariaya, Quezon. A total of 61 pump irrigation systems serving a total of 175 lowland rice farms comprised the sample. Pumps were selected on the basis of their accessibility to the road. All farms served by these systems were included in the sample.

Information about production and irrigation practices including costs and returns to pump use was collected from the farmer users. Data on initial cost of the system as well as its operating and maintenance expenses were taken from the pump owners as well as water tenders.

3.0 THE PUMP IRRIGATION SYSTEM

3.1 Description

The majority of the pump systems studied were owned by the landlord but were used and operated by the tenants. They were of the centrifugal type driven by diesel engines. The pump transmits its power from the prime movers to the pump either through direct coupling or through a belt. On the average, a pump operates for about 13 hours a day consuming about 3.5 gallons of diesel.

Pumps studied in Laguna were bought and installed through private dealers and contractors with brake horsepower (BHP) ranging from 3.0 to 8.0.

Most of the systems were installed in the late fifties, some as early as 1956 and some as late as 1963. The capacity of the average pump was about 260 gpm, consuming an average of 2.70 gallons of diesel in 12 hours. The average area irrigated per system was 7 hectares.

In Sariaya, Quezon, pumps studied were all obtained through the Irrigation Service Unit (ISU) on a 15-year amortization period plus a 6 percent interest on the unpaid balance. Most of the systems were installed in 1965-1966 with BHP ranging from 6 to 6.5. Pump capacity was 300 gallons per minute with a fuel consumption of 2.86 gallons of diesel in 16.5 hours. The average area irrigated per system was 12 hectares. Most systems in Sariaya have open drilled wells and only a few have the closed wells common in Laguna and Batangas.

Bigger pumps with BHP ranging from 10 to 25 were studied in San Juan, Batangas. Similar to Sariaya, most of the systems were obtained through the ISU on a 15-year amortization period plus 6 percent interest on the unpaid balance. Most of the systems were installed between 1963 and 1967. Fuel consumption averaged 4.85 gallons in 10 hours with a pump capacity of 540 gallons per minute. The average area irrigated per system was 27 hectares.

One big difference noted between ISU and privately manufactured pumps is in the price of diesel used. ISU pump owners were given quotas of 100 liters per horsepower per season of diesel at the rate of 8-1/3 centavos per liter, whereas private pump owners obtained their diesel from private sources at a commercial rate of 17 centavos per liter. However, ISU pump owners were required to provide large containers for these quotas which often posed a big problem for them.

3.2 Reasons for installing the system

The most common reason for installing the system is to increase production and income as reported by 62 out of 203 responses. Other reasons given for pump installation fall within this general purpose. (Table 1)

Twenty-nine percent of the total responses wanted to increase area cultivated and enable double-cropping; 21 percent wanted to solve inadequate water supply while 9 percent wanted to safeguard against drought. Others installed the system to facilitate weeding and other farm operations. Some mentioned non-economic reasons, such as keeping up with the popular use of pumps and because it is the desire of the landlord. One farmer installed the system for business purposes; i.e., to rent out the pump to other farmers at a certain fee.

TABLE 1. Reasons for installing the pump irrigation system.

	Laguna		Batangas		Quezon		All Prov.	
	No.[a]	%[b]	No.[a]	%[b]	No.[a]	%[b]	No.[a]	%[b]
To increase production and income	44	36	8	19	10	26	62	32
To increase size of area and enable double-cropping	22	18	22	51	15	40	59	29
To solve problem of inadequate water supply	31	26	7	16	5	13	43	21
To safeguard against drought	14	11	-	-	4	10	18	9
To facilitate weeding and other farm operations	6	5	5	12	3	8	14	7
To keep up with the popular use of pumps	5	4	-	-	-	-	5	2
For business purposes	-	-	1	2	-	-	1	[c]
Desire of landlord	-	-	-	-	1	3	1	[c]
Total responses	122	100	43	100	38	100	203	100
Number of farmers	87		53		35		175	

[a] Some reported more than one reason for installing the pump system.

[b] Based on total responses.

[c] Less than one percent.

3.3 Initial capital investment on pump

The initial cost of the system averaged ₱3,934 for privately installed pumps and ₱9,343 for ISU pumps. This cost includes the value of the engine, the pump, the housing, installation and drilling. (Table 2).

The biggest item of investment in case of privately owned pumps was the cost of pump and engine, accounting for 63 percent of the total capital invested. This was followed by the cost of installation which includes drilling, casing, pipes and fittings and other costs associated with pump set-up.

In the case of ISU pumps, the biggest item of investment was the pump house amounting to about ₱4,355. The value of pump and engine accounted for 40 percent of the total capital, followed by cost of installation (13 percent).

In general, the area irrigated per system increased with the size of the pump (BHP). The same was true with the investment cost of the system. Pumps with lower BHP cost much less than those with 10 to 25 BHP.

3.4 Number of users per system and arrangement in pump use

The number of users per pump system ranged from 1 to 23 farmers. Batangas pumps has the greatest number of users per system, ranging from 6 to 23, followed by Quezon pumps with 3 to 11. The least number was noted in Laguna pumps with 1 to 5 users. (Table 3)

In Laguna, most of the systems were used by a single individual where he himself decided when and how much to irrigate his field. It was only in case of pump breakdown that he consulted the landlord. In case of 2 to 5 users per system, a verbal agreement was made as regards water use depending on the size of farm, distance from the pumping unit and farm operations being performed. In case of water shortage, farmers took turns in the planting of a second crop.

In case of Sariaya pumps, the distribution of water was regulated by a water tender who was usually a tenant of the farm. His compensation was a percentage of the irrigation fee paid by the farmer-user. This fee was in cavans of palay amounting to 10 to 15 percent of the gross harvest, excluding harvester and thresher's share. The irrigation fee covers the cost of operating and maintaining the system.

Similar to Sariaya pumps, a water tender was hired to regulate water use among tenants using Batangas pumps. His compensation was either a fixed salary or a certain percentage of the harvest, or both. A much higher rate, 20 percent, was charged for the use of the system.

TABLE 2. Characteristics of pump irrigation system and cost by size of the system (BHP);.61 pump irrigation systems, Laguna, Batangas and Quezon, 1967-68.

				PRIVATELY MANUFACTURED PUMPS				
Size of engine (BHP)	No. of farms	No. of pumps	Area Irrigated per pump (ECA)	Capital Investment Per Pump				
				Engine[a/]	Pump[b/]	Installation[c/]	Housing[d/]	Total
3.0	15	11	5.62	1,314.55	515.45	1,120.00	273.09	3,223.09
4.0	14	11	6.76	1,446.82	488.64	1,042.73	266.36	3,244.55
5.0	28	14	8.50	2,235.50	593.57	1,256.46	237.26	4,322.79
6.0	20	10	8.75	2,225.00	480.60	1,086.75	341.00	4,133.35
7.0	3	1	9.50	2,500.00	485.00	1,216.50	350.00	4,551.50
8.0	5	4	4.47	1,560.00	667.50	1,408.31	452.50	4,088.31
10.0	8	1	14.42	3,590.00	500.00	1,320.00	300.00	5,710.00
16.0	17	1	34.30	1,200.00	5,600.00	1,645.00	420.00	8,865.00
All system	110	53	7.90	1,837.72	630.49	1,171.05	293.26	3,933.52
				I S U PUMPS				
6.0	18	2	17.69	4,160.25		1,408.90	2,147.48	7,716.62
6.5	17	4	4.04	2,876.25		925.00	3,674.54	7,745.71
10.0	6	1	8.62	2,694.00		300.00	4,696.54	7,690.54
25.5	22	1	51.06	7,169.14		3,400.00	11,150.00	21,719.14
All system	63	8	16.93	3,711.08		1,277.22	4,354.92	9,343.22

a/ Engine plus its accessories.

b/ Pump plus its accessories.

c/ Installation includes the cost of drilling, casings and drive shoe, pipes and fittings, cost of labor and other pump expenses.

d/ Housing includes the cost of the pump house plus the labor together with cost of stilling basin as the case may be.

TABLE 3. Number of users per system.

Number of users	LAGUNA		BATANGAS		QUEZON	
	Number of systems reporting	Percent	Number of systems reporting	Percent	Number of systems reporting	Percent
1	27	53	-	-	-	-
2	16	31	-	-	-	-
3	6	12	-	-	1	17
4	-	-	-	-	2	32
5	2	4	-	-	-	-
6	-	-	1	25	1	17
7	-	-	-	-	1	17
8	-	-	1	25	-	-
11	-	-	-	-	1	17
17	-	-	1	25	-	-
23	-	-	1	25	-	-
Total	51	100	4	100	6	100

3.5 Cost sharing arrangement in the use of pump

In the landlord owned pump systems, the tenants either shared in the operating and maintenance expenses of the system or paid a fixed rent for its use. In a majority of cases, the landowner provided the fuel and oil and at harvest time deducted an equivalent amount of palay from the gross harvest.

Seven major cost sharing arrangements are shown in Table 4. About half of the farmers studied were under Case 1 arrangement wherein the tenant was charged a certain fee for the use of the pump. This fee was in cavans of palay amounting to 10 to 20 percent deducted from the gross harvest to cover all operating and maintenance expenses of the system. This was the most common cost sharing arrangement observed in Quezon and Batangas.

In the case of Laguna pumps, the operating cost of the system was either shared equally or paid solely by the tenant and landlord while the maintenance cost was either shared or paid solely by the landlord. There were extreme cases where either the landlord or the tenant paid for all operating and maintenance costs of the system.

3.6 Problems in using pump

About 36 percent of the farmers studied reported problems with regard to the use of the pump system. Most of the problems reported were general and some of the farmers had difficulty defining them. (Table 5)

Inadequate water supply was the most common problem aired. In the case of Laguna pumps, this was attributed to the fact that most of the pump systems studied had been coupled to previously free flowing artesian wells. No drilling cost was required on these pumps but lowering of the water level and the size of the original pipes limited the discharge capacity of the system. Moreover, as more pump systems are installed in the area, there is always the risk that a newly dug well will draw water from the acquifer of existing wells, thereby reducing its water yield. In the case of Sariaya, inadequate water supply was attributed to the low water holding capacity of their soil which is sandy to sandy loam in nature.

Other problems reported were expensive repairs and maintenance cost of the system plus the high cost of spare parts and accessories, especially of diesel engines. Moreover, most of these spare parts were often not available in the locality, so that a farmer had to go to Manila to purchase them.

Priority in pump use was another problem reported by farmers of the bigger pump systems of Sariaya, Quezon and San Juan, Batangas. Pump

TABLE 4. Sharing arrangement in the operating and maintenance expenses of the landlord owned pump systems, 175 pump irrigated lowland rice farms, Laguna, Batangas and Quezon, 1967-1968.

Terms in sharing expenses	Number[a]	Percent
Case I - Tenant is charged a certain fee for pump use (paid in cavans of palay after every harvesting season)	85	49
20% of gross harvest (excluding H and T share)	(53)	(32)
15% of gross harvest (excluding H and T share)	(4)	(2)
10% of gross harvest (excluding H and T share)	(6)	(3)
10% of gross harvest (including H and T share)	(11)	(6)
10% deducted from tenant's share	(11)	(6)
Case 2 - Fuel, oil and grease expenses are equally shared by landlord and tenant; repairs and maintenance expenses are paid solely by landlord	55	33
Case 3 - All operating and maintenance expenses of the system are shared equally by landlord and tenant	16	9
Case 4 - Fuel expense is shared by landlord and tenant while oil, grease and repairs and replacement expenses of the system are paid solely by landlord	6	3
Case 5 - Fuel, oil and grease expenses are paid by the tenant while the landlord pays for the repairs and replacement costs	5	3
Case 6 - Landlord pays for all operating and maintenance expenses of the system	4	2
Case 7 - Tenant pays for all operating and maintenance expenses of the system	1	1
Total	172	100

[a] Two owner-operated pump systems were excluded in the analysis.

TABLE 5. Problems encountered in using the pump system, 175 lowland rice farms, Laguna, Batangas and Quezon, 1967-1968.

Nature of problem	Number of farms reporting[a]	Per-cent[b]
Inadequate water supply	29	41
Expensive repair and maintenance cost	14	20
High cost of spare parts (especially diesel engine)	9	13
Inavailability of spare parts and accessories	6	8
Too much attention needed	5	7
Priority in pump use	5	7
Too much oil consumption	3	4
Total responses	71	100
Number of farms reporting problems	63	36
Number of farms reporting no problems	112	64
Total number of farms	175	100

[a] Some farmers reported more than one problem.

[b] Based on total responses.

systems in these places had about 10 to 23 users, with the result that often a farmer had to sleep in the field just to be able to irrigate his farm in time for his operations. This was the reason why some farmers complained of too much attention required to pump use.

3.7 Operating cost per hectare by province

The average cost of using a pump ranged from ₱116 in Laguna to ₱220 in Batangas (Table 6). The difference in cost between the three provinces was caused by the difference in the size of pump (BHP) studied in the area. Bigger pumps, requiring higher operating and maintenance expenses, were studied in Batangas whereas the pump systems studied in Laguna were smaller and required a lower operating and maintenance cost per hectare.

Of the total cost of using the system, variable costs accounted for 40 to 77 percent and fixed costs, 60 to 23 percent.

Fuel and oil was the biggest variable item, followed by overhauling cost. In Batangas and Sariaya, the cost of operating and maintaining the system was paid in cavans of palay so that the distribution of costs among variable items could not be differentiated.

Fixed costs, which are composed of depreciation and interest, averaged ₱60 in Batangas and ₱89 in Sariaya. Depreciation of pumps, computed at a useful life of 10 years, was the biggest fixed cost item followed by the interest charged on the total investment at the rate of 6 percent.

3.8 Actual operating cost of using the system vs. costs paid in kind

In Batangas and Sariaya, a different cost sharing arrangement was noted. The landlord provided for all operating and maintenance expenses of the system and at harvest time deducted an equivalent amount of palay from the gross harvest. The irrigation fee which ranged from 10 to 20 percent of the gross harvest was based on the price of palay at the farm level.

A comparison between the actual cost incurred by the landlord to that being paid by the farmer user showed a difference of ₱78 in the case of Batangas and ₱46 in the case of Sariaya (Table 7). The big difference in costs could be attributed to the low maintenance expenses of the systems studied, inasmuch as most of them were recently installed and not much was required in the way of repairs and replacement cost. Moreover, since most of these systems were obtained through the ISU, diesel could be obtained at a cheaper rate of 8-1/3 centavos per liter.

TABLE 6. Operating and maintenance expenses per hectare, Laguna, Batangas and Quezon, 1967-1968.

Items	LAGUNA		BATANGAS		QUEZON	
	Value	Percent	Value	Percent	Value	Percent
Number of farms	87		53		35	
Area per farm (ha.)	2.43		1.14		1.10	
Number of pumps	51		4		6	
Area irrigated per pump (ECA)	7.26		27.10		12.63	
Costs of using pump:	pesos	percent	pesos	percent	pesos	percent
Variable Costs:						
Fuel & oil	41.29	35				
Repairs & replacement	0.33	b/	169.42*	77	91.44*	51
Overhauling	5.54	5				
Sub-total	47.16	40	169.42	77	91.44	51
Fixed Costs:						
Depreciation[a/]	53.61	46	30.35	14	55.21	30
Interest at 6%[a/]	15.69	14	20.55	9	33.62	19
Sub-total	69.30	60	50.90	23	88.83	49
Total	116.46	100	220.32	100	180.27	100

a/ Based on the average total investment of 61 systems, depreciation was computed at a useful life of 10 years.

b/ Less than 1%.

* These cost items are paid in kind in the case of Batangas and Quezon farms. The value of palay paid was based on the price of palay at farm level.

TABLE 7. Operating and maintenance expenses per hectare, Batangas and Quezon, 1967-1968.

Items	BATANGAS Actual	BATANGAS In kind	BATANGAS Difference	QUEZON Actual	QUEZON In kind	QUEZON Difference
Cost of Using Pump:						
Variable Costs:						
Fuel & oil	26.66					
Repairs & replacement	4.35	169.42		1.92	91.44	
Overhauling	-			-		
Wage of water tender	60.35			23.10		
Sub-total	91.36	169.42	78.06	45.70	91.44	45.74
Fixed Costs:						
Depreciation	30.35	30.35		55.21	55.21	
Interest at 6%	20.55	20.55		33.62	33.62	
Sub-total	50.90	50.90		88.83	88.83	
Total	142.26	220.32	78.06	134.53	180.27	45.74

The higher cost in Batangas was due partly to the high rate of their irrigation fee, amounting to 20 percent of the gross harvest as compared to Sariaya's 10 to 15 percent.

3.9 Comparative operating cost per hectare of ISU and privately installed pumps

A comparative analysis of the operating and maintenance expenses per hectare between ISU and privately installed pump systems showed a lower cash operating cost in favor of ISU pumps (Table 8).

ISU pumps edged out private pumps on the cost of fuel and oil since it costs only half as much as that used by private pumps. However, since ISU pumps were much bigger and had a greater number of users than private pumps, they required a higher wage for their water tender.

On the fixed cost items, private pumps exhibited a higher depreciation cost inasmuch as most of them date back to the 1950's. And since privately installed pumps were much older than ISU pumps, the interest charged on the system was lower than ISU pumps.

4.0 ECONOMIC ANALYSIS OF PUMP PERFORMANCE

4.1 Changes due to pump use

4.1.1. Wet season yields. There is no direct evidence on this point from this study itself, but Bureau of Agricultural Economics (BAE) data for Southern Tagalog as well as for other regions point to a differential in favor of irrigated over rainfed area. In 1965-66, the difference was 9.4 cavans per hectare and in 1966-67, it was 2.5 cavans.

4.1.2. Varieties. Farmers from the three provinces reported that after acquiring pumps there was a general tendency to shift away from a broad range of traditional varieties commonly grown for home consumption towards, IRRI and College varieties, Malagkit, Intan and BPI-76, varieties intended for the market.

In Laguna, the number of farmers growing these varieties rose from 21 percent under rainfed conditions to 49 percent under pump irrigation. Please note that the pumps in question were installed before the improved varieties had time to make an impact. Following a survey of Laguna farmers in 1967-68, however, IRRI workers reported that improved varieties were then dominant. In the case of Quezon and Batangas, where most of the systems studied were recently installed, the impact of pump installation on varieties used was very prominent.

TABLE 8. Comparative operating and maintenance expenses per hectare of ISU and privately installed pumps, Laguna, Batangas and Quezon, 1967-1968.

ITEMS	ISU Pumps		Private Pumps	
	Value	Percent	Value	Percent
Number of farms	63		112	
Area per farm (ha.)	2.15		3.74	
Number of pumps	8		53	
Area irrigated per pump (ECA)	16.93		7.90	
COSTS OF USING PUMP:				
Variable Costs:	pesos	percent	pesos	percent
Fuel and oil	19.23	16	40.91	33
Repairs and replacement	3.94	3	0.49	a/
Overhauling	-	-	4.89	4
Wage of water tender	24.45	20	11.89	10
Sub-total	47.62	39	58.18	47
Fixed Costs:				
Depreciation	44.41	36	50.86	41
Interest at 6%	30.79	25	15.31	12
Sub-total	75.20	61	66.17	53
Total	122.82	100	124.35	100

a/ Less than one percent.

4.1.3. Fertilizer use. Prior to the installation of pumps, 71 percent of the farmers studied were not using fertilizer and of the remainder, about one-third applied not more than one bag per hectare. Under irrigated conditions, 93 percent were applying fertilizer and two-thirds of these used at least 2 bags per hectare.

4.1.4. Cultural practices. Other changes that accompanied pump irrigation included a marked swing from the "broadcast" and "ordinary" to the "straight-row" method of transplanting.

There was also an expanded use of pest and disease control measures and more intensive weeding, including a shift to rotary weeding.

4.1.5. Double-cropping. For the three provinces studied, the double-cropped area averaged 81 percent of the cropland area with Quezon exhibiting the highest percentage, 97 percent, and Laguna the least, 75 percent (Table 9).

4.2 Costs and returns analysis

A useful and practical approach to pump irrigation economics is to ask what difference pump irrigation makes to production and input patterns, and to express this difference in terms of pesos. Following this approach, the data for Laguna, Batangas and Quezon has been analyzed into actual costs and returns associated with pump irrigation for crop year 1967-68.

4.2.1. Production per hectare by province. Production per hectare averaged 59 cavans in Laguna, 79 cavans in Batangas, and 85 cavans in Quezon (Table 10). The discrepancy in yield among provinces could be attributed to physical as well as social factors. Laguna at the time of the study was suffering from rat infestation, thus had a low yield. Moreover, the relationship between the landlord and tenant in most farms in Laguna was not as close as in Batangas and Quezon, since most of the landlords were of the absentee type. Batangas and Quezon farms did not have any rat problem at the time of the study. Furthermore, a close relationship existed in these areas between the landlord and the tenant, with the landlord supervising farm operations and farm inputs used.

By season, average production was higher during the wet season in Batangas and Laguna than in the dry season. Lower yields during the dry season were brought about by inadequate water supply from pumps resulting in the non-utilization of some of the irrigated wet season area for second-cropping. Moreover, in case of Laguna farms, some of the farmers who had adequate water were reluctant to plant a second crop for fear that rats would concentrate on their farms because nearby, farms did not do so.

TABLE 9. Land resource characteristics of 175 pump irrigated lowland rice farms, Laguna, Batangas and Quezon, 1967-1968.

ITEMS	Laguna	Batangas	Quezon
Number of farms	87	53	35
Average size per farm (ha.)	2.43	1.14	1.10
Land use intensity:			
Effective crop area (ha.)	4.25	2.05	2.17
Land double-cropped (ha.)	1.82	0.91	1.07
% double-cropped	75	80	97

$$\% \text{ double-cropped} = \frac{\text{area double-cropped}}{\text{farm size}}$$

TABLE 10. Production per hectare, per pump and per farm by season, Laguna, Batangas and Quezon, 1967-1968.

	Laguna	Batangas	Quezon
Production per hectare (cavans)			
Wet season	65.91	83.77	79.38
Dry season	50.39	74.36	90.57
Average for the year	58.81	78.85	84.68
Production per pump (cavans)			
Wet season	270.08	1,082.70	527.77
Dry season	189.52	1,054.01	541.79
Average per year	426.71	2,136.71	1,069.56
Production per farm (cavans)			
Wet season	155.69	94.15	90.47
Dry season	116.83	79.55	98.51
Average for the year	250.14	161.26	183.35
Price per cavan (pesos)			
Wet season	20.10	16.40	16.40
Dry season	18.10	17.18	15.62
Average for the year	19.10	16.79	15.96

4.2.2. Costs and returns per hectare by province. The total costs of producing a hectare of irrigated lowland palay averaged ₱1,098 in Laguna, ₱1,177 in Batangas, and ₱1,212 in Quezon (Table 11).

Of the total cost, 73 to 88 percent were non-cash charges and 12 to 77 percent, cash charges.

The landlord's share for the use of land and pump was the biggest cost item accounting for 29 to 33 percent of the total cost. This was followed by the harvester and thresher's share (14-22 percent) and hired labor (5-13 percent), the biggest cash cost item.

In general, about 70 percent of the total cost incurred in rice production was for land, pump and other capital items; about 21 percent went to labor and 9 percent for factor inputs such as fertilizer, chemicals and seeds.

It could be noted from the table that Laguna surpassed Batangas and Quezon in the cash cost category while Batangas and Quezon surpassed Laguna in the non-cash cost item. This was explained by the fact that cost of labor as well as operating and maintenance expenses of the pump were all paid in cash in Laguna, whereas in Batangas and Quezon, farm operations were mostly performed by the operator and his family and the operating and maintenance expenses of the system were all paid in kind in the form of irrigation fees given to the pump owner.

Total farm return per hectare as measured by the value of palay produced and the increase in farm inventory was highest in Quezon, ₱1,480, and lowest in Laguna, ₱1,146. Likewise, the net gain per hectare obtained after deducting total cost from total farm return was highest in Quezon, ₱269 and lowest in Laguna, ₱48.

4.2.3. Costs and returns analysis by group of farms. To have a more meaningful economic analysis of pump performance, data from the Laguna farms for crop year 1964-65 to crop year 1966-67 were analyzed.

The analysis is outlined in the four tables at the end. Each table corresponds to a situation with which a particular sub-group of the Laguna farms was associated. The first group contains seven farms whose operators reported no serious production problems over the period. The second group of 22 farms suffered in one degree or another from rat attack, which resulted in reduced yields and/or a contraction in the area planted to a second crop. The third group of 13 farms ran up against a miscellany of problems including unfavorable weather and trouble with the pump.

TABLE 11. Costs and returns per hectare of producing pump-irrigated lowland palay, Laguna, Batangas and Quezon, 1967-1968.

ITEMS	Laguna Value	 Percent	Batangas Value	 Percent	Quezon Value	 Percent
Production per hectare (cavans)	58.81		78.85		84.68	
	pesos	percent	pesos	percent	pesos	percent
Cash Costs:						
Hired labor	142.49	13	54.27	5	57.03	5
Food	10.45	1	19.85	2	22.82	2
Fertilizers	78.86	7	54.09	5	73.99	6
Farm chemicals	15.08	1	9.83	a/	20.06	2
Fuel & oil	41.29	4			4.94	a/
Repairs & replacement	5.87	1			0.03	a/
Others	3.45	a/	0.82	a/	5.16	a/
Total Cash Costs	297.49	27	138.86	12	184.03	15
Non-Cash Costs:						
Landlord's share for the use of land b/	361.59	33	340.85	29	369.83	30
Seeds	21.90	2	24.74	22	29.93	2
Harvester's & thresher's share	149.08	14	218.80	19	273.79	22
Hungkoy patio rent	10.89	1	-	-	-	-
Hired labor in kind	14.43	1	-	-	-	-
Unpaid family & exchange labor c/	44.69	4	68.07	6	45.46	4
Unpaid operator's labor c/	85.61	8	116.36	10	94.66	8
Irrigation fee	0.26	a/	169.42	13	91.44	8
Interest	26.38	2	47.92	4	56.39	5
Depreciation: T & E d/	30.40	3	22.10	2	10.79	1
Pump	53.61	5	30.35	3	55.21	5
Others	1.54	a/			0.07	a/
Total Non-Cash Costs	800.38	73	1,038.61	88	1,027.57	85
Total Farm Returns	1,145.51		1,358.27		1,480.50	
Total Costs	1,097.87	100	1,177.47	100	1,211.60	100
Net Gain	47.64		180.80		268.90	

a/ Less than one per cent.

b/ Landlord's share is the net share for the use of land. All cash expenses shouldered by the landlord are deducted from the gross share of the landlord.

c/ Unpaid operator, family and exchange labor is valued on actual days of labor inputs at the wage rate of ₱3.50.

d/ Refers to tools and equipment.

4.2.4. Production per hectare by farm group. A comparison of yields among the three groups of farms showed that the no problem farms have yields almost double that of the rat problem and the pump and weather problem farms. (Table 12)

4.2.5. Costs and returns analysis by farm group. The main portion of each costs and returns table contains details of costs actually incurred in dry season rice production within each group of farms. These costs are expressed per hectare irrigated in the dry season and are divided into appropriate landlord and tenant categories. The residual obtained after deducting total costs from the gross return is the net return to unpaid labor and management and to the capital invested in the pump system.

Note in the table that only the costs and returns for the dry season are considered on the assumption that under rainfed condition, no dry season crop is possible. Therefore, the costs and returns associated with a dry season crop are an additional increment to farms under pump irrigation. It was further assumed that no additional unpaid labor inputs are required for wet season production as compared to rainfed.

No Problem Farms (Table 13). The first group of farms in the "No Problem" farms composed of 7 farmers reporting no serious production problem over the period. All land under this group was double-cropped with an average area of 2 hectares per farm in each season.

Depreciation of pump under the "No Problem" farms was estimated at a useful life of 10 years. All expenses associated with the pump system such as repairs and replacement and depreciation are paid solely by the landlord. Expenses on factor inputs such as fertilizer, chemicals, fuel and oil, seeds and harvester and thresher's share are shared equally by the landlord and tenant. In the case of hired labor, landlord and tenant shared equally the cost of transplanting, and the remainder, including the cost of a hired tractor, was paid solely by the tenant.

For the "No Problem" farms, wet season net return was arbitrarily set at ₱75 per hectare and for the dry season, the actual net return incurred was used. The total annual net return is then projected to a 2-hectare basis which is the average size of the "No Problem" farms.

For the first group of farms, return to capital was 71 percent and to labor and management, P11 per day.

Rat Problem Farms (Table 14). The second group of farms had 22 respondents who suffered some rat damage which resulted in reduced yields and/or a contraction in the area planted to a second crop.

TABLE 12. Production per hectare by farm group, season and year, Laguna.

	FARM GROUPS		
	No problem	Rat problem	Weather and pump problem
Production per hectare (cavans)			
Crop year 1964-1965			
Wet season	65.30	36.08	44.59
Dry season	62.17	30.21	36.12
Average for the year	63.73	33.87	41.69
Crop year 1965-1966			
Wet season	77.25	40.07	46.27
Dry season	66.11	28.90	32.18
Average for the year	71.60	36.81	40.92
Crop year 1966-1967			
Wet season	77.79	42.62	48.89
Dry season	67.21	31.81	34.35
Average for the year	71.50	39.82	43.17

TABLE 13. Costs and returns from pump irrigation for "No Problem" farms.

Items	Total	Landlord's share	Tenant's share
1. Dry season costs per hectare irrigated			
Hired labor	121.00	21.30	99.70
Hired tractor	16.50	-	16.50
Harvesters' and threshers' shares	166.60	83.30	83.30
Fertilizer and chemicals	59.50	29.75	29.75
Seeds	20.40	10.20	10.20
Fuel and oil	39.80	19.90	19.90
Repairs and replacement	13.70	8.10	5.60
Depreciation	91.60	60.20	31.40
Other costs	9.20	2.70	6.50
Total costs	538.30	235.45	302.85
2. Dry season yield and gross return per hectare irrigated			
Yield (cavans)	65.10	32.55	32.55
Price/cavan	19.50		
Gross return	1,271.00	635.50	635.50
3. Dry season net return per hectare irrigated			
Gross return	1,271.00	635.50	635.50
Less Costs	538.30	235.45	302.85
Net Return	732.70	400.05	332.65
4. Additional net return per hectare irrigated in the wet season	₱ 75.00	40.00	35.00
5. Annual net return on a 2 hectare of cropland basis			
Wet season 2 hectares x ₱ 75	150.00	80.00	70.00
Dry season 2 hectares x ₱732.70	1,465.40	800.10	665.30
Total	1,615.40	880.10	735.30

6. Net return to landlord's capital investment in the pump irrigation system, and to unpaid labor and management in production.

Return to capital = 71%
Return to labor and management = ₱11.00 per day

TABLE 14. Costs and returns from pump irrigation for "Rat Problem" farms.

ITEMS	Total	Landlord's share	Tenant's share
1. Dry season costs per hectare irrigated			
Hired labor	99.10	17.40	81.70
Hired tractor	3.00	-	3.00
Harvesters' and threshers' shares	68.80	34.40	34.40
Fertilizer and chemicals	37.20	18.60	18.60
Seeds	17.60	8.80	8.80
Fuel and oil	33.20	16.60	16.60
Repairs and replacements	5.20	2.20	3.00
Depreciation	117.50	69.50	48.00
Other costs	16.20	1.90	14.30
Total costs	397.80	169.40	228.40
2. Dry season yield and gross return per hectare irrigated			
Yield (cavans)	29.70	14.85	14.85
Price per cavan	17.60		
Gross returns	522.90	261.45	261.45
3. Dry season net return per hectare irrigated			
Gross return	522.90	261.45	261.45
Less costs	397.80	169.40	228.40
Net return	125.10	92.05	33.05
4. Additional net return per hectare irrigated in the wet season	37.50	29.00	8.50
5. Annual net return on a 2 hectare of cropland basis			
Wet season 2 has. x P37.50 =	75.00	58.00	17.00
Dry season 1 ha. x P125.10 =	125.10	92.05	33.05
Total	200.10	150.05	50.05

6. Net return to landlord's capital investment in the pump irrigation system, and to unpaid labor and management in production.

Return to capital = 13%
Return to labor and management = P1.30 per day

For the "Rat Problem" group, the area actually planted in the dry season was only half of the wet season area.

Depreciation of pumps in this group was computed at a useful life of 12 years on the assumption that pumps under this condition are not fully used (unlike those on the "No Problem" farms).

The analysis of costs incurred in rice production for this group was treated in the same fashion as that of the "No Problem" farms. However, net additional return for the wet season was assumed at ₱37.50 per hectare to account for the risk involved under the above mentioned condition.

For the "Rat Problem" farms, percent return to capital decreased to 13 percent and to labor and management, ₱1.30 per day.

Pump and Weather Problem Farms (Table 15). The third group of 13 farms ran up against a miscellany of problems including unfavorable weather and trouble with the pump.

For the "Pump and Weather Problem" farms, about 60 percent of the wet season area or about 1.20 hectares was planted to a dry season crop.

As with the "Rat Problem" farms, useful life of the pump system was extended to 12 years. Similarly, the net return for the wet season was assumed at ₱37.50 per hectare.

Net return to capital for the "Pump and Weather Problem" farms was 14 percent, and for labor and management, ₱4.55 per day.

5.0 REMARKS AND CONCLUSION

In studying different groups of farms, there will always be factors other than those selected by the analyst which affect returns to some extent. This is to be expected especially in non-experimental survey work where the researcher has no control of exogenous factors. Nevertheless, the results obtained in the present analysis are consistent with the argument that earnings from pump irrigation may vary widely, depending upon particular circumstances.

Based on this study, one can conclude that pump irrigation has paid off handsomely where no serious problem have been encountered. It has still yielded a positive return, on the average, to both capital and labor even where certain problems have seriously detracted from the potential realizable return.

TABLE 15. Costs and returns from pump irrigation for "Pump and Weather Problem" farms.

ITEMS	Total	Landlord's share	Tenant's share
1. Dry season costs per hectare irrigated			
Hired labor	110.30	16.40	93.90
Hired tractor	11.50	-	11.50
Harvesters' and threshers' shares	91.50	45.75	45.75
Fertilizer and chemicals	51.20	25.60	25.60
Seeds	19.50	9.75	9.75
Fuel and oil	38.70	19.35	19.35
Repairs and replacements	78.20	77.20	1.00
Depreciation	88.90	69.30	19.60
Other costs	24.80	4.40	20.40
Total costs	514.60	267.75	246.85
2. Dry season yield and gross return per hectare irrigated			
Yield (cavans)	33.70	16.85	16.85
Price per cavan	20.30		
Gross return	685.80	342.90	342.90
3. Dry season net return per hectare irrigated			
Gross return	685.80	342.90	342.90
Less costs	514.60	267.75	246.85
Net return	171.20	75.15	96.05
4. Additional net return per hectare irrigated in the wet season	37.50	16.50	21.00
5. Annual net return on a 2 hectare of cropland basis			
Wet season 2 hectares x ₱37.50 =	75.00	33.00	42.00
Dry season 1.20 has. x ₱171.30 =	205.44	90.40	115.04
Total	280.44	123.40	157.04

6. Net return to landlord's capital investment in the pump irrigation systems, and to unpaid labor and management in production.

Return to capital = 14%
Return to labor and management - ₱4.55 per day

Obviously, had conditions been different, returns would have also been different from those indicated. One could have assumed lower or higher price levels, more severe or less severe incidence of problems, or different combinations and quantities of inputs and arrived at different conclusions.

What counts is the environment within which pump irrigation operates on the individual farm. This environment can best be defined by the farmer concerned. General conclusions based on this study can only supply broad guidelines; they cannot indicate specifically the results which will be achieved in individual cases.

SHALLOW WELL IRRIGATION IN NUEVA ECIJA

Charles A. Robertson[1]

1.0 INTRODUCTION

Three distinct production effects are associated with the introduction of shallow well irrigation onto previously rainfed land in Nueva Ecija. Wet season yields of local varieties are increased, more land is allocated to new varieties in the wet season, and extra crops of rice or vegetables are grown in the dry season.

The scale of additional production resulting from shallow well irrigation depends, in the wet season, on the number of hectares benefited and the realization of related yield and varietal effects. Outside the wet season additional production is a function of increased yields and land use intensification.

Until recently there has been little technical data available which could provide a basis for evaluating the likely impact of increased numbers of shallow wells, in terms of area benefited and associated production level. In the absence of such information certain rules of thumb have been used to estimate aggregate area and production magnitudes and to compare the economics of different sizes and types of irrigation systems. In programming agricultural development at the national level, as in advising individual farmers on irrigation problems, it is obviously important to use realistic estimates.

This paper proceeds by quoting potential pump capability in terms of riceland served and level of production. The technical coefficients and assumptions which give rise to these capability guidelines are also indicated. This is followed by a preliminary analysis of data from a stratified random sample of shallow well operations in Nueva Ecija in 1968/69, with emphasis on explaining why there was a performance gap between actual and potential achievement. All shallow well pumps in the sample were distributed through the Irrigation Service Unit (Department of Public Works and Communications) which has played a leading role in the very rapid development of pump irrigation facilities in the Philippines.

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[1] Visiting Instructor, Agricultural Economics Department, U.P. College of Agriculture. The author wishes to acknowledge the help of Marcial Faigmane, Research Assistant, UPCA, in data collection and organization.

1.1 Pump capability

According to standard estimates[2], a 4" pump with a rated capacity of 300 gpm has the potential to irrigate approximately 10 hectares of lowland rice in the wet season. Similarly, a 5" pump, rated at 600 gpm, should be able to irrigate 20 hectares. It is assumed that pumps operate for 16 hours per day. Conversion of the estimated discharge onto a continuous pumping basis implies water delivery at the rate of 20 gpm per hectare (1.26 liters per second per hectare).

Dry season pump capability is more of an unknown factor. Some economic feasibility calculations have been made on the basis of only one irrigated crop per year.[3] In others, it is implicitly assumed that hectarage capacity is the same in both seasons.[4] The latest guideline sets dry season capability at 30 percent of the wet season area[5]; 3 hectares for 4" pumps and 6 hectares for 5" pumps.

The range of expected rice yields under irrigated conditions runs from 80 cavans[6] to 150 cavans[7] per hectare, depending upon particular assumptions relating to techniques of production, input levels and management. For its economic feasibility calculations the Irrigation Service Unit[8] uses 100 cavans per hectare. These rates are all based on the assumption that new varieties are being grown, and they are in sharp contrast to annual rainfed yields of around 40 cavans per hectare[9], for lowland rice in Central Luzon.

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[2] Teofilo M. Mendoza, "Underground Water Development, Utilization, and Conservation," (mimeo), Project Investigation and Development Division, Irrigation Service Unit, Department of Public Works and Communications, Annex II.

[3] *Ibid*.

[4] Maximo G. Ramos, "Ground Water Utilization for Irrigation Purposes," (mimeo), Ground Water Utilization Division, Irrigation Service Unit, Department of Public Works and Communications, Table 1.

[5] Irrigation Service Unit staff, personal communication, October 1969.

[6] United States Department of the Interior, Bureau of Reclamation, *A Report on the Central Luzon Basin*, Washington, November 1966, p. 146.

[7] The International Rice Research Institute, *Cultural Practices for Profitable Rice Production*, General Leaflet 1 (revised) Manila, January 1968.

[8] Ramos, *loc. cit.*

2.0 SHALLOW WELL IRRIGATION IN THE WET SEASON, 1968/69

2.1 Area irrigated

Table 1 shows the areas irrigated in the wet season by the 4" and 5" pumps appearing in the sample.

It is clear from this table that the areas served were much smaller than the standard area estimates. The question here is whether this gap reflects scarcity of well water in relation to the area which could have benefited from irrigation, or whether it signifies a relatively weak demand for supplemental water during the wet season. No detailed information is available from this study on intensity of pump use or rate of discharge during the 1968/69 wet season. But it can be argued that availability of well water was not likely to have limited the irrigated hectarage.

As wet season rainfall diminishes, farmers with access to pumps presumably irrigate their fields according to need. Relatively little demand will be made on the pump unit at this time on a per hectare basis, because the soil contains residual moisture and rainfall is still making some contribution. Farmers are therefore unlikely to try to economize on water use by restricting the area which is served by the pump, so long as water is required on the land and provided that its flow is permitted by the local topography. If this is so, it can be concluded that the wet season irrigated area is governed primarily by the demand for irrigation. It is not a function of the available supply of water. The 6-7 hectares irrigated on average per well in 1968/69, therefore, reflects demand in that particular year. There would appear to have been a considerable demand gap in 1968/69 in terms of underutilization of available water supplies. This is highlighted in the frequency distribution of area irrigated per well, presented in Table 2.

Out of 46 in total, 26 wells irrigated 5 hectares or less, averaging only one quarter of the area served per well by the 7 wells with the highest coverage. The existence of unused capacity on this scale, especially in a drought year, warns against using the standard estimates to link pump numbers and irrigated area when making projections.

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[9] Calculated from data in mimeographed summary tables of rice production, based on 1966 and 1967 Crop and Livestock Survey sample indications of the Department of Agriculture and Natural Resources, Bureau of Agricultural Economics.

TABLE 1. Area of rice irrigated per well, by pump size and type of well, wet season 1968/69, in hectares.

	4" Pumps		5" Pumps
	Open wells	Driven wells	Driven wells
Number of wells	15	21	10
Area irrigated	7.0	5.8	6.0

TABLE. 2. Distribution of area irrigated per well, wet season, 1968/69.

Area (hectares)	Number of wells
0 - 2.5	8
2.6 - 5.0	18
5.1 - 7.5	4
7.6 - 10.0	9
Over 10	7
Total	46

In the event of a long drought, like that of 1968, the pump irrigated areas may suffer from water shortage, depending on the relationship between rate of discharge and the number of hectares relying on the pump for water. Scarcity of water will then be reflected in low yields.

2.2 Yield

The yield effect associated with shallow well irrigation in the wet season can be defined by comparing data for rainfed rice production with corresponding data from land irrigated from pumps. Where possible, paired observations relating rainfed and irrigated production were made on the same farm. Due to the general availability of irrigation water in certain areas, however, it was not possible to collect rainfed data at every pump site. Communal and private gravity systems, pumps situated on creek banks and shallow wells not included in the sample contributed to the total supply of irrigation water available in the immediate vicinity of the sample pump sites. Because of this, only 30 rainfed observations could be obtained. These were from land units chosen so as to minimize structural variations between them and the units of irrigated land in respects other than water availability, including soil type and system of tenure.

A simple comparison of yields* of local varieties on rainfed and pump irrigated farms is set out in Table 3.

Table 3 shows that farmers who grew local varieties and supplemented rainfall with irrigation water from their shallow wells obtained considerably higher yields than farmers on rainfed land - 55 cavans as opposed to only 34 cavans on unirrigated lands.

Statistical analysis, using a t-test on paired observations, supports the hypothesis that mean irrigated yield is higher than mean rainfed yield, at the 1 percent level of significance. Although average expenditure per hectare on chemicals and fertilizers was also higher on the irrigated land, the difference is not statistically significant at the 5 percent level. This inference is rather puzzling since one would have expected farmers on rainfed land to use less fertilizers and chemicals, in view of the presumably greater risks which they face in production. It does, however, bring out the dominant role of irrigation in maintaining production levels in a drought year. It would appear that a large portion of the wet season irrigated area has yet to experience the modernizing influence of irrigation as a vehicle for technological change.

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* All yield figures quoted in this paper refer to rough rice.

TABLE 3. Rice yield of local varieties on pump irrigated and rainfed farms and associated levels of expenditure on fertilizer and chemicals, wet season, 1968/69.

	Rainfed	Irrigated
Number of observations	26	26
Yield per hectare (cav.)	34	55
Fertilizer and chemicals per hectare (₱)	46	57

2.3 Choice of variety

Twenty-six of the rainfed sites supported local varieties and only 4 had new varieties. This is in contrast to the irrigated areas where more than half of the farmers using water from shallow wells had taken wholly or partially to the new varieties, which accounted for 28 percent of the rice area. This result supports the earlier findings of Liao in Laguna and that of other researchers in Laguna and Central Luzon. Liao[10] concluded that irrigation was the most essential factor affecting the spread of new varieties, while other IRRI workers found that no improved varieties were being grown on 31 rainfed farms included in a 1967/68 survey.[11]

On the other hand, 70 percent of pump users who had adopted new varieties stated that even if they did not have irrigation facilities they would still be prepared to grow these varieties. There is, therefore, a disparity between what farmers on rainfed land actually do and what farmers on irrigated land say they would do if their fields were rainfed. This apparent conflict may be related to a greater familiarity with and confidence in the new varieties on the part of pump owners who have experience of growing these varieties. Or it may simply be a measure of an understandable gap between stated intentions of individuals and their subsequent activities.

It should be noted, however, that 72 percent of the pump irrigated riceland was still planted to local varieties, which of course yielded much less than 100 cavans per hectare, the standard estimate for the new varieties. Actual yields of new varieties were also relatively modest, averaging 66 cavans per hectare. These figures highlight the gap between anticipated yield under favorable conditions and actual achievements in the field.

3.0 SHALLOW WELL IRRIGATION IN THE DRY SEASON, 1968/69

Table 4 shows the areas of rice and vegetables irrigated from shallow wells in the dry season. The values in the top half of the table were calculated on the basis of all wells for which data is available. The divisors used to obtain

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[10] David S. H. Liao, "Studies on Adoption of New Rice Varieties," International Rice Research Institute, Saturday Seminar, November 9, 1968.

[11] The International Rice Research Institute, "Type of Farm, Use of Hand Tractors, and Yield Relationship, 115 Farms, Laguna and Central Luzon, 1967-68", (mimeographed table), Agricultural Engineering Survey.

TABLE 4. Area of rice and vegetables irrigated per well, by pump size and type of well, dry season, 1968/69, in hectares.

	4" pumps		5" Pumps
	Open wells	Driven wells	Driven wells
	All wells		
Number of wells	14	22	10
Rice	2.4	1.8	2.7
Vegetables	0.9	0.6	0.7
	Wells in operation for rice or rice and vegetable production		
Number of wells	11	17	7
Rice	3.1	2.3	3.8
Vegetables	0.7	0.3	0.3

the area figures in the lower part of the table exclude 4 wells not in operation during the dry season and 7 wells which were used for vegetable production only. The most common reason offered for not growing a rice crop was the high risk of rat attack.

Where rice was grown, the area served was small in extent compared to the estimated irrigable area of pumps working at their full rated capacity (30 percent of their wet season capacity). Before considering possible reasons for this, yield figures for the dry season are presented. Provided that water can be supplied in adequate quantity, conditions for rice production are often more favorable in the dry than in the wet season, due to abundance of solar energy and low risk of weather damage. A comparison of wet and dry season yields and respective inputs of fertilizer and chemicals is set out in Table 5.

Despite much higher usage of fertilizers and chemicals, the mean yield of rice in the dry season on pump irrigated areas was 11 cavans lower than in the wet season and 17 cavans below the wet season yield on areas sown to the new varieties.[12] This outcome is contrary to what one would expect in making seasonal yield comparisons.

Two pieces of evidence invite an examination of water availability as the crucial variable explaining both the small scale of operation in the dry season and the low yields obtained. One is that at nearly 70 percent of the pump sites where March measurements were made, the pump was, at that time, operating more or less on a 24-hour day basis. The other is that many of the fields observed had large cracks in the soil and in some cases leaf curl was evident. Twenty-three percent of respondents stated that their entire second crop area had suffered from drought and a further 30 percent reported partial drought damage.

During the dry season, there was little effective rainfall in the Nueva Ecija plain after October. Rice crops grown on land adjacent to the shallow well sites were wholly dependent on ground water throughout the season. The extent to which shallow well pumps were underutilized or crops affected by drought was, therefore, closely related to pump discharge and the scale of dry season production.

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[12] Twenty-one farmers grew new varieties in both seasons. A 2-tail t-test on paired observations indicates a significant difference at the 10 percent level between mean wet and dry season yields. A parallel test on seasonal inputs of fertilizer and chemicals leads to rejection of the null hypothesis of no difference, at the 1 percent level, in favor of the one-sided alternative that the mean input level is higher in the dry than in the wet season.

TABLE 5. Rice yield on pump irrigated land by season and variety and associated levels of expenditure on fertilizer and chemicals, 1968/69.

	Wet season		Dry season
	All varieties	New varieties	New varieties
Yield per hectare (cavans)	60.3	66.1	49.1
Fertilizer and chemicals per hectare (₱)	64.3	90.3	143.2

From January onwards the rate at which water was delivered from the shallow wells was measured at intervals at as many pump sites as possible. The measuring instrument was a 3" Parshall flume. So far, four sets of data have been collected, the respective mean dates for successive sets falling in January, March, May and October.

Table 6 contains rates of discharge for a constant sample of 25 shallow wells. The figures show a marked seasonal pattern with discharge rates toward the end of the season being much lower than in January and October. There was considerable variation in delivery rates from pump to pump. Nine 4" and three 5" pumps were discharging less than 100 gpm in March and the highest rate was 315 gpm.

The decline in discharge rate is probably closely linked to the downward seasonal movement of the water table, which dropped by about 6 feet between January and May. In March the static water level in 11 open wells averaged just under 16 feet to the center line of the pump. Beyond the 15 feet point there is likely to be "a sharp decrease in discharge and efficiency"13/. This emphasizes the importance for dry season production of programming the scale of plantings, not according to water availability in December and January, but in line with likely availability towards the middle and latter part of the growing season.

4.0 SUMMARY

Rule of thumb estimates of the benefits resulting from shallow well irrigation need revision, according to 1968/69 experience in Nueva Ecija, taking account of the following factors:

1. Underutilization of available pump capacity in the wet season.

2. Yield levels considerably lower than those associated with high level management under favorable physical conditions.

3. Prevalence of local varieties on wet season irrigated areas.

4. Water availability conditions in the dry season which limited both scale of production and yields to levels below the more conservative of the standard estimates.

5. Threat of rat damage in the dry season leading to limitation of pump use for rice production.

13/ Mendoza, op. cit., p.6.

TABLE 6. Pump discharge in gallons per minute and speed in revolutions per minute by type of well and size of pump for a constant sample of 25 shallow wells in selected months in 1969.

Month	4" Pumps				5" Pumps	
	Open wells (8)		Driven wells (11)		Driven wells (6)	
	GPM	RPM	GPM	RPM	GPM	RPM
January	146	1456	133	1513	208	1425
March	120	1425	106	1545	145	1350
May	104	1462	105	1570	158	1367
October	180	1422	160	1502	269	1321

( ) Figures in brackets show number of wells.

EXPERIMENTS ON THE ECONOMICS OF WATER DISTRIBUTION

Rodolfo D. Reyes[1]

1.0 INTRODUCTION

A rational farmer manager who decides to provide irrigation to his rice farm by tapping underground water sources faces the following problems:

(1) Capital requirements for new pump and engine, well construction and subsequent expenses associated in putting up a pump irrigation system.

(2) Organization and design of the system.[2]

(3) Optimum distribution of water.[3]

Consideration of the above problems could provide intelligent basis for decision on:

(a) Type of pump system he needs

(b) Feasibility for repayment of cost of irrigation facilities

(c) Maximization of farm income[4]

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[1] Research Scholar, Agricultural Economics, IRRI.

[2] This involves how the resources of the farm will be organized and used in combination with the irrigation system, i.e., the farmer may decide on using the pump system in providing supplemental irrigation in the wet season for all hectarage of the farm and plant less hectarage for the dry season crop. He could achieve this by basing his design on the wet season water requirement and choosing the type or combination of systems that is expected to yield the wet season water requirement. He could also consider the construction of water reservoir whenever feasible to build up high irrigation delivery capability of the system and increase the dry season hectarage.

[3] It is the choice of optimum irrigation intensity that will be provided the crop, i.e., the amount of water and the interval of irrigation that will be given to the crop at each cropping season (wet and dry) which in the final analysis will provide maximum expected annual farm income.

[4] Farm income is defined in terms of an administrator's viewpoint. This is the net farm return considering total cost.

8-1

Decision on the type of system needed will depend on the resources of the farm. Likewise, this will vary accordingly on how the system will be organized and designed to suit the financial capability of the farmer. Feasibility for repayment of cost of irrigation facilities and maximization of farm income depend on how the irrigation capacity of the system will be utilized. All of these decisions involve the issue of water distribution. Hence, this paper will explore on the economics of water distribution as a tool of analysis to offer guidance to those who are confronted with the same problems. The first step is to establish a suitable functional relationship between water delivery and rice yield from experimental data.5/ The results from the analysis will then be incorporated in the economic analysis of pump irrigated from project models.6/

1.1 Limitation of experimental results

There are strong objections on extending application of experimental results to farm level situations. Farm yield data, however, are characterized by unmanageably large variability due to various unidentified and uncontrolled factors. This placed poor confidence in the use of farm data in establishing a suitable yield-water use relationship. On the other hand, controlling various factors affecting yield is possible by experimentation. Also, reliability and confidence on

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5/ The experiment will also provide technical data on field irrigation during the land preparation and the cropping season periods.

6/ In combination with subsequently solicited data on farm level pump performance technical data gathered from the experiment will be used to formulate pump irrigated farm project models.

estimation could be attained by refining experimental technique and randomization. It is admitted that expected rice yield do vary according to rice variety, soil and environmental condition and level of management. The user of experimental results should consider these sources of variation to decide on the appropriateness of results for a particular situation. In like manner the application of experimental results to farm level situation made in this paper should be interpreted with due caution.

1.2 Hypotheses

This study will test the following hypotheses:

(a) It is hypothesized that the nature of the rice yield-water input relationship will either be a diminishing or a sigmoid curve (refer to Fig. 1). The diminishing curve is a typical yield-water use relationship for upland crops. The sigmoid curve was suggested by Prof. G. Levine[7] as the probable nature of the relationship for lowland rice based from limited information.

(b) It is also hypothesized that for a given rice yield-water use functional relationship, pump system performance data and current cost estimates the following is expected.

For pump systems operating at less than full capacity and at fixed daily pumping hours during the cropping season the resulting hectarage that could be serviced by the system do not guarantee maximization of farm income

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[7] Former Visiting Professor of Agricultural Engineering, UPCO Graduate Program, UPCA, Laguna.

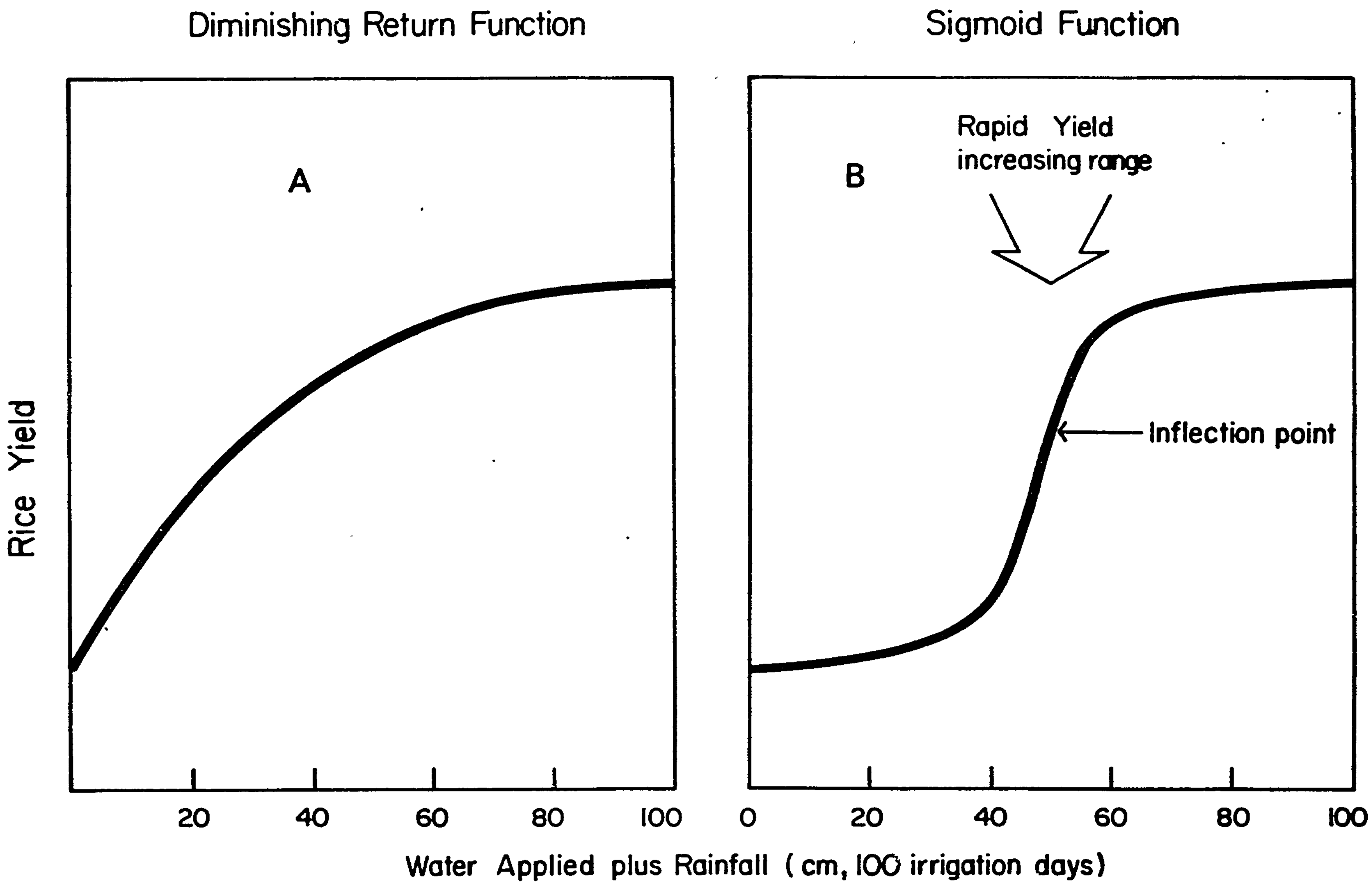

Fig. 1. Two possible hypothesis on the functional relationship between rice yield and irrigation water.

and capital repayment feasibility at flooded irrigation intensity levels. On the other hand, maximization of the above items at flooded situation could be arrived at if the systems are operated at the maximum possible daily duration (full capacity).

It is commonly observed that pump systems are operated at about 10 hours a day. According to pump and engine manufacturers this is much below full capacity operation. It is argued that if the water source is open and unlimited, full capacity operation denotes maximum pump system daily operating hours depending on the limitation set by the prime mover. Small prime mover engine units suited for 4 or 5 inch diameter centrifugal pumps could be run continuously and need only an hour or two of rest every 24 hours interval. Moreover, the big diesel engines used in deepwell turbine pump systems could negotiate continuous operation without rest for about a month period.

With shallow tubewell pump systems full capacity operation is more arbitrary. The maximum daily pumping hours possible depends more on the water supplying capacity of the underlying water acquifer source which in turn is highly variable and unpredictable. However, in the case of deepwell pump systems several water acquifer sources are tapped to provide a more dependable water yield suitable for continuous pumping operation. Hence, at farm level situation full capacity operation is determined by the type of pump and well system and the water supplying capacity of the underground source or sources. For purposes of this study full capacity operation for 4 and 5 inch diameter shallow tubewell centrifugal pump systems will be set at 20 hours a day. It will be set at 24 hours a day for the deepwell turbine pump system.

Increasing the daily pumping hours of the system above 10 hours will involve additional cash expenses for farm and pump system operation and working hours for the farmer. It could also lower the level of the water table which in turn would decrease pumping capacity. For a combination of these reasons farmers continue operating their systems below full capacity as arbitrarily set above.

1.3 Objectives

This study has the following objectives:

(a) To establish a suitable functional relationship between rice yield and water input with the use of experimental data.

(b) To make use of the results of the above analysis and other available information in synthesizing the following:

(1) average pump and well models, cost estimates for capital investment and pump system operation, and

(2) pump irrigated farm project models.

(c) To conduct economic analysis for the different farm project models placing emphasis on feasibility for capital cost repayment and maximization of farm income.

2.0 THE YIELD-WATER INPUT RELATIONSHIP FOR LOWLAND RICE

Limited work has been done on the rice yield-water input relationships. Effect on yield of water input levels at and above saturated field condition has been adequately investigated. But yield response due to levels below field saturation which is the critical portion of the relationship is not understood. To say something about the economics of water distribution it is necessary to understand the whole range of yield response at water input levels below and above saturated field condition. Two field experiments were conducted during the dry seasons of 1968 and 1969 at the institute experimental farm. The purpose was to generate data to ascertain the nature of the said relationship and ultimately establish a suitable functional equation that could be used in an economic analysis.

2.1 The experiments

In the 1968 experiment, the water application treatments were instituted at panicle initiation stage of the crop. For purposes of investigation of water distribution the results were considered exploratory. Using technical information suggested by this experiment a new experimental site was developed at the same vicinity wherein a concluding experiment was conducted in the dry season of 1969.

2.1.1. The experimental plots. The layout for the new experimental site and plots is illustrated in Fig. 2. Seven plots (plot 1-7) each of size 12 x 12 meters were laid out at T_8, while two plots (plots 8 and 9) were constructed at T_7, about 40 cm lower in elevation than T_8. Each of the plots was bottomless and bounded by single layer of 18" wide fural metal sheet that was buried to a foot depth below ground level. Plot 9 however, was provided with two extra metal levee rings extending outward at one meter interval. This plot was intended for measurement of the water consumptive use of flooded rice.

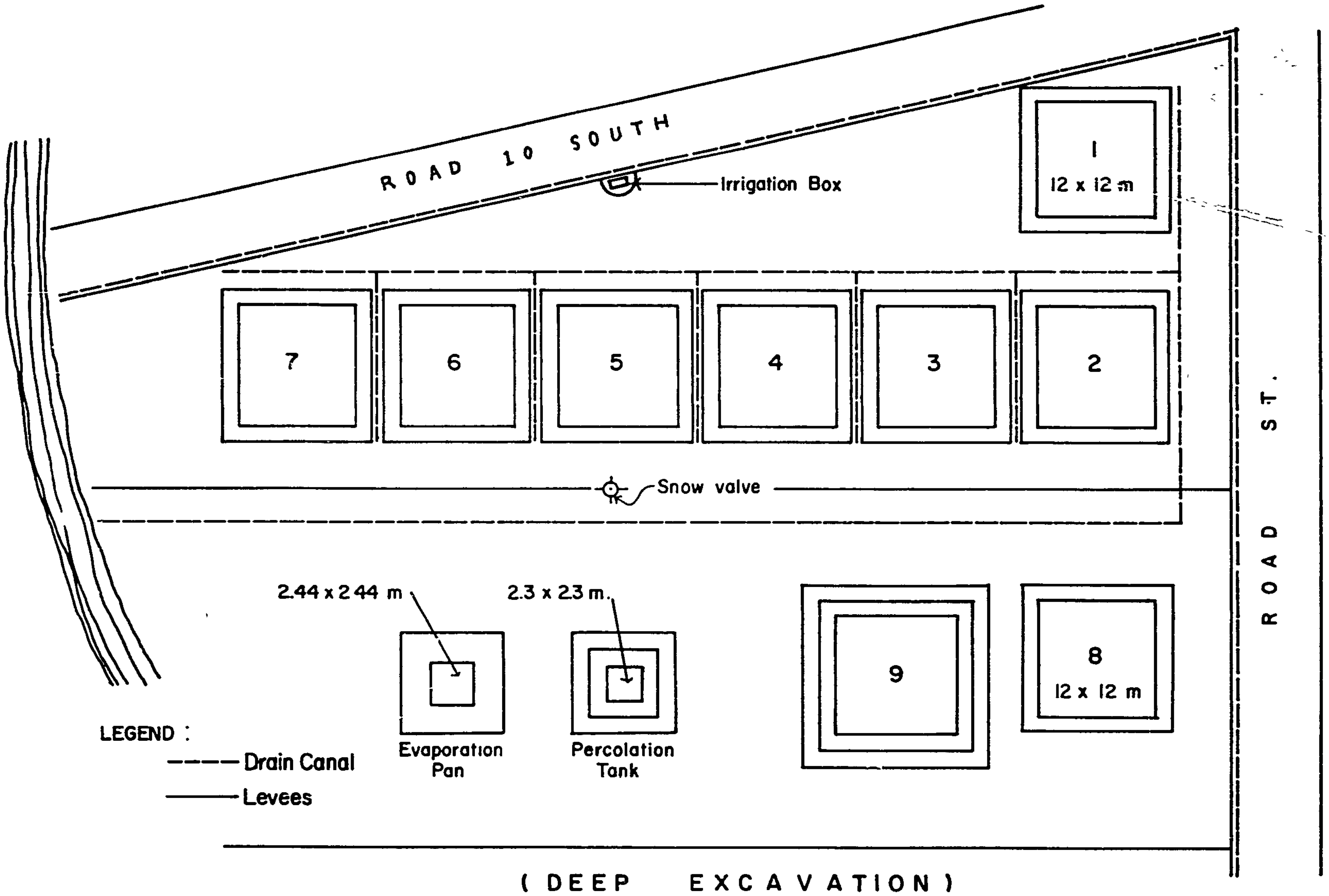

Fig. 2. Schematic layout of experimental area and plots at T_7 & T_8. IRRI, 1969 dry season.

An evaporation pan and a percolation tank were also installed on the space extending southeast of plots 8 and 9.

2.1.2. The water application treatments. Seven levels of irrigation intensity were investigated. The range in treatments was 2 mm-depth/day up to 8 mm-depth/day taken at 1 mm-depth/day interval plus two continuously flooded control treatments. The treatments were allocated to the experimental plots in a sequential as opposed to a random fashion as follows: 8 mm-depth/day to plot 1, 7 mm-depth/day to plot 2 down to 2 mm-depth/day to plot 7. This was suggested since a continuous nature of functional relationship was sought and possible water movement between plot borders was speculated. The continuous flood control treatments were likewise allocated to plots 8 and 9.

2.1.3. The irrigation operation. During irrigation operation water amount applied to the experimentally treated plots was measured thru a 1" diameter volumetric water meter. Irrigation water was pumped from the institute's underground irrigation box and conducted to the experimental plots using a 2" x 2" diameter centrifugal pump coupled by belt and pulley to an aircooled engine in combination with other improvised accessories.

Water requirement data for land preparation was taken as shown in Table 1. With the field dried down to 60 percent soil moisture content, the total amount of water used up in the operation was 132 mm-depth. For practical purposes about half of the total requirement could be applied to immediate flood and soil saturate. The other half of 66 mm-depth could be applied during the process of plowing, first harrowing, basal fertilizer application and final leveling operations. It is to be noted here that

TABLE 1. MM-depth of water used for land preparation of experimental plots. Dry season, 1969, IRRI. [a]

Plot No.	Soil moisture content [b]	Water requirement [c]		Total
		Immediate flood to soil saturate	Additional amount applied up to fertilizer application and final leveling	
	(%)	(mm-depth)	(mm-depth)	(mm-depth)
1	66.3	d/	d/	118.24
2	58.4	51.22	77.47	128.70
3	61.2	d/	d/	131.51
4	62.8	60.75	69.56	130.31
5	61.4	62.35	81.82	144.18
6	57.8	62.50	79.34	141.84
7	50.5	64.20	68.61	132.82
Average	59.8	60.20	75.36	132.51

a/ The whole experimental site at the beginning of the season was flooded and leveled. Metal levees were installed extending about a foot downward below ground level around the periphery of every 12 x 12 meter experimental plots. About a month after initial flooding land preparation was done.

b/ Soil moisture content (O. D. basis) obtained before immediate flooding to soil saturate.

c/ During the process of irrigation water added to each of the experimental plots was measured volumetrically thru a 1" ø water meter.

d/ For these plots, only total requirement for land preparation was recorded.

NOTES:

(a) Soil type: Maahas clay.

(b) Land preparation: Jan. 18-20, 1969. Plowing, harrowing, basal fertilizer application and final leveling was done after 24 hours of soil saturation. Land preparation for each experimental plot was completed in two days.

(c) Transplanting: Jan. 22, 1969. Thin sheath of surface water was maintained for 2 days prior to transplanting.

for a given definite area with controlled irrigation land preparation could be finished in two days with the use of hand tractors. It should also be expected that more water will be used up if land preparation operations especially soil puddling is delayed.

Two days after land preparation, 11 day old dapog IR8 seedlings were transplanted. Full water application treatments were instituted at 8 to 13 days after transplanting (D. A. T.)[8/] This was to give allowance for seedling establishment before subjecting them to deeper water depths. Throughout the crop season the irrigation treatments were applied at 5 day interval. Cumulated 5 days irrigation volume requirements were applied since observations suggested this schedule to be typical of farm practice.

The relationship between crop maturity, irrigation period, and water application treatments is shown in Table 2. Termination of the water application treatments was done at approximately one to two weeks before expected harvest. For the experimental plots which were below soil saturated condition from flowering to maturity (7, 6, 5, 4, 3, and 2 mm-depth/day treatments) it was felt necessary to extend irrigation up to a week before expected harvest. In flooded condition (8 mm/ day and the flood control plots) irrigation was terminated two weeks before expected harvest. The experimental result showed that decreasing the amount of water application prolonged crop maturity and, hence, the irrigation period.

2.1.4. Other production inputs. Other inputs of production as management, fertilization, weed control, rat and insect control were fixed at high levels and kept

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[8/] It has been a practice of researchers at the International Rice Research Institute to write 'days after transplanting' in abbreviated form as D. A. T.

TABLE 2. Rice grain yield, crop irrigation period and crop maturity of IR8 at different irrigation intensity levels. Dry season, 1969, IRRI. [a]

Irrigation input levels (mm-depth/day)	Irrigation period (D. A. T.)	Crop maturity (D. A. T.)	Grain yield [b]	
			Kgms/ha	Kgms/ha/day
2	3 - 138	-	-	-
3	3 - 138	145	0	0
4	3 - 138	145	89	0.61
5	3 - 118	126	4,650	36.90
6	3 - 113	121	7,301	60.30
7	3 - 108	119	8,735	73.40
8	3 - 103	116	8,832	76.10
9.13	3 - 103	116	8,881	76.50

a/ The crop was transplanted using 11-day old dapog seedlings at 25 x 25 cm. between hills about 2 days after land preparation.

b/ Average of eight 8 sq. meter yield samples from one plot replicate.

constant for all experimentally water treated plots.

(a) $(NH_4)_2SO_4$ fertilizer was basally applied at 100 kgm N a.i. per hectare to all experimental plots.

(b) Handweedings were provided whenever necessary depending on the requirements of the experimental crop. More weedings were done for treated plots that dried up early without giving a chance for canopy to close in. This was observed particularly in 2, 3, and 4 mm-depth/day treatments. However, handweeding was done only twice for other treatments;[9/] one at 15 D.A.T. and another at 40 D.A.T.

(c) Thirty six inches wide corrugated metal sheets were provided as fence around the whole experimental crop area at the start of the experiment. A double layer of fine wire was installed at the top of the metal sheet and electrified every night time starting from twilight to early morning. This was to keep rats out of the crop. Rat baits inside and outside of the experimental plots were also provided when necessary.[10/]

(d) For insect control, diazinon and sevin were alternately applied every other 10 to 14 days. Least moisture treated plots when they started to dry out were

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[9/] In terms of weed control all other treated plots are normal. 7 mm-depth/day is intermittently flooded up to about flower, while 6 and 5 mm-depth treatments have saturated soils and canopy about closed in at the time of second weeding (40 D.A.T.).

[10/] In spite of this precaution there are still some cases of isolated rat damage. It was observed that some preference are given by the pest for field plots with unsaturated field condition.

provided with folidol and sevin sprays.[11] At about booting stage to crop maturity insecticide application was reduced from precautionary to control level.

2.2 The experimental yield data

Rice yield data was obtained from the experiment described above. The results are presented in Table 2. At 2 mm-depth/day treatment, the crop did not flower up to 145 D. A. T. when the experiment was terminated. While at 3 mm-depth/day treatment the crop did flower but did not produce grain. In the case of 4 mm-depth/day crop yield could be considered practically zero. Very few panicles produced normal grains. However, these normal grains were rare in these few panicles. To get the yield as presented, these panicles were painstakingly harvested and threshed by hand. On the other hand, yield figures at other treatments were obtained using normal harvesting procedures.

An account of the soil condition in the treated plots may help explain the above yield data. The 7 mm/day treatment was kept intermittently saturated to flooded condition up to about flowering. From flowering to maturity the water level in the plot continuously declined until it fell below saturated condition. On the other hand, the 8 mm/day treatment slowly built up water depth from transplanting toward the end of the vegetative stage. During the reproductive stage (flower initiation up to termination of irrigation) water level in the plot was maintained at approximately from 4 to 8 cm depth. Experimental plots provided with irrigation intensity levels below 7 mm-depth/day were observed to be below soil saturated condition during the bulk of the cropping season. The 6 mm/day treatment started to progressively dry out at about 60 D. A. T.; the 5 mm/day at about 40 D. A. T.; the 4, 3 and 2 mm/day treatments at much earlier periods. Drying out at these plots indexed gradual build up of water use deficit from periods before flower to maturity. Plant height was shorter on the plots with lower water treatments.

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[11] This will introduce differences in the estimation of production cost. Excepting for treated plots 8 and 7 mm-depth/day other plots dried out before flower. These varied conditions will involve different types of insecticides and interval of application, hence, costs.

The data indicated that yield decreased sharply from 6 to 5 mm-depth/day treatment which is quite a narrow range. This stresses the extreme sensitivity of lowland puddled rice to drought and the uncertainty in applying less water (below soil saturated condition) if the supply of water especially during the crop reproductive period is not warranted.

2.3 Analysis of the yield data

The data was plotted in a scatter diagram and eye fitted as shown in Fig. 3 to test the first hypothesis. The result indicated the sigmoid function as a reasonable form of the rice yield-water use relationship. The scatter diagram also showed that the quadratic and the logistic equation models could be used to fit the data.

2.3.1. Fitting the data to a suitable functional equation.

Two functions were fitted from the yield data. The results are as follows:

(a) Quadratic function:

$$\hat{Y} = -26{,}743.15 + 9037.17\,X - 565.914\,X^2$$

$$R^2 = 0.967$$

where:

$\hat{Y}$ = estimated yield (kgms/ha)

X = mm-depth/day water application levels

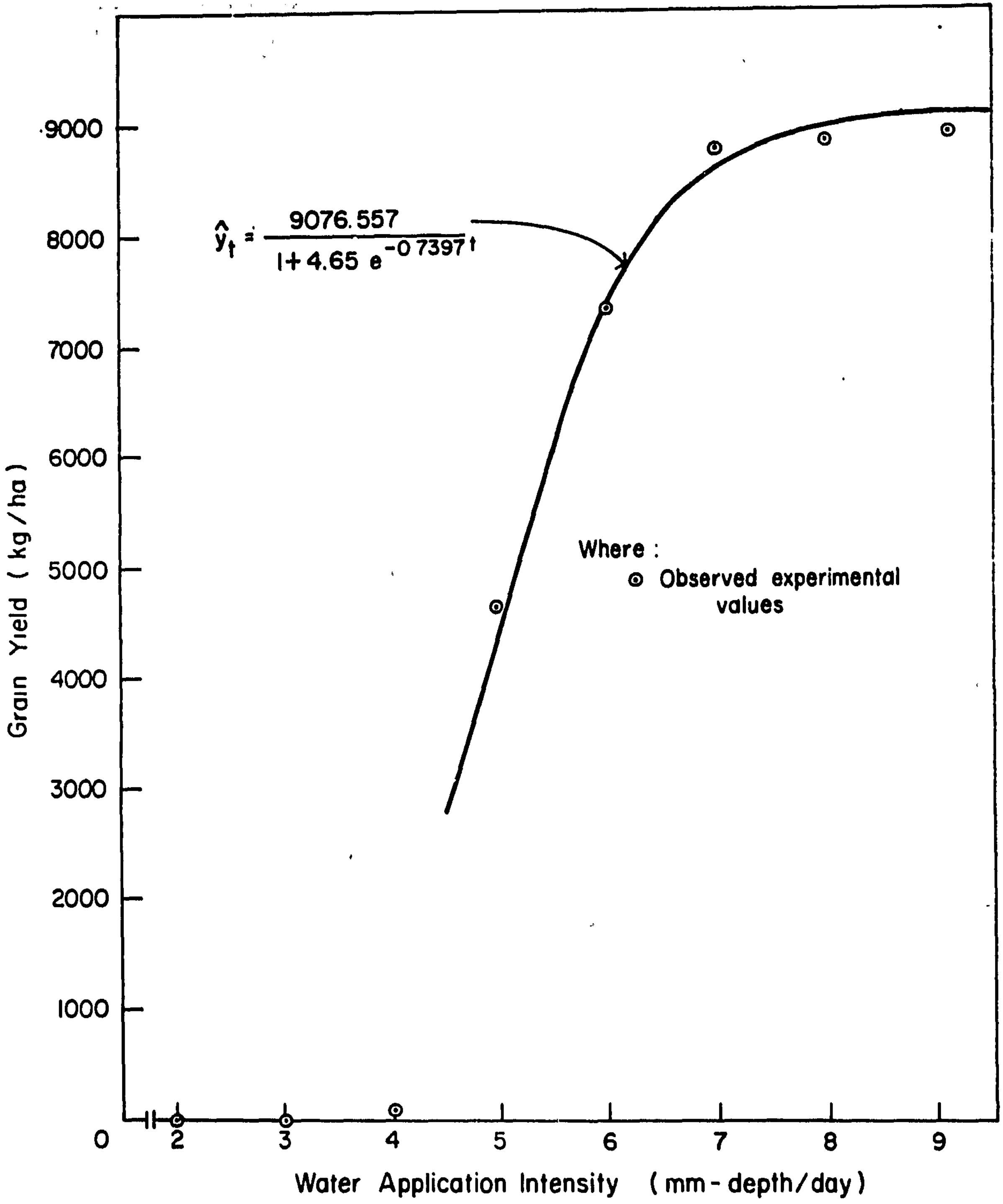

Fig. 3. Rice yield response of IR8 to different water application intensity treatment. Dry season, 1969. IRRI.

This function was arrived at with the use of multiple regression analysis technique, where in the functional model, $Y = \alpha + \beta_1 X_1 + \beta_2 X_2$, X was substituted for X_1 and X^2 for X_2.

(b) Logistic function (Tintner method)

$$\hat{Y}_t = \frac{9076.557}{1 + 4.65\ e^{-0.7397\ t}}$$

$$R^2 = 0.993$$

where:

$\hat{Y}_t$ = estimated yield (kgms/ha)

t = 1 for 4.5 mm-depth/day irrigation level

t = 2 for 5.0 mm-depth/day irrigation level

:

:

t = 9 for 8.5 mm-depth/day irrigation level

The analysis involved the use of the logistic equation model of the form: $Y_t = \frac{K}{1 + be^{-at}}$ where K, a and b are parameters. For illustration in the calculation of the values of the parameters , please refer to Appendix A.

Both the fitted functions gave a high R^2 value. In the quadratic form, however, the increasing influence of the negative coefficient of the square of irrigation input effected yield decrease at the continuously flooded situation (9.13 mm/day treatment). This was thought as improbable. In the logistic equation the estimated yield values at the flooded situations approach assymptotic levels, which is more in keeping with the trend indicated by the yield data and the literature.[12] Following this line of reasoning, it was decided to use the logistic function as a basis for yield estimation in the subsequent economic analysis that follows. The scatter diagram of the yield data and the estimated logistic function are presented in Fig. 3.

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[12] For example, Akin William, (1969), found out that there is no statistically significant difference between yields obtained at experimental plots which are continuously saturated and those continuously flooded at 2.5, 5.00, 7.5 and 10 cm depths.

2.3.2. The form of the relationship in Fig. 3 indicates that rice should be provided with irrigation intensity above a minimum level to produce yield. In the case of this dry season experimental crop, this minimum level is at about 4 mm/day. It is implicitly suggested in the illustration that in the wet season added rainfall amount will reduce this minimum irrigation level and at the same time the cloudiness in the period will effect yield level reduction.

The drastic yield reduction in a narrow range of irrigation application denotes that in terms of productivity aspect extreme care should be exercised in the allocation of available water from the irrigation system. Allowance on system's capability should be provided by limiting the command area during the wet season to a size in which irrigation could be warranted when rainfall fails. The extremely variable rainfall pattern and the yield-water use relationship tend to give merit to the old practice of raising rice in a puddled flooded field condition when the water management level is low. The amount of water stored in a puddled soil would tide the crop for about a month when the rains fail. In the case of pump irrigated farms, however, the degree of water control can be kept high. In these farms, it is a possibility that farm income could be maximized at irrigation intensity levels lower than the flooded field situation.

3.0 ECONOMIC ANALYSIS OF PUMP IRRIGATED FARM PROJECT MODELS

The analysis in this section has been done as an illustration and is not intended as a basis for recommendations. The result could be interpreted as an intelligent guess of what may be expected about the profitability of operating pump irrigation systems under alternative farm level situations. It should be emphasized that it was done using the dry season crop as the basis. Different result should be expected if either the wet season or combination of wet and dry season crops were used as basis.

The following analysis tried to work out the issues of maximization of farm income and capital repayment feasibility by optimizing water distribution levels in the organization and design of pump systems. It tried to provide basis for ascertaining the profitability of lengthening the daily working hours of the pump systems above 10 hours. It also implicitly answers, the problem of deciding what type of system is needed in a particular farm situation through a limited number of budgets made for specific farm project models.

The analysis will assume the following:

(1) The experimentally derived rice yield-water input functional relationship holds at farm level situations simulated by the different pump irrigated farm project models. Yields are higher than as expected at farm level situation. They are not adjusted in this paper. Observations of conditions on pump irrigated farms indicate that on many fields water is added at approximately 7 and 8 mm/day.13/

13/ Personal communication with Jack Kampen, Visiting Instructor, UPCA Ag. Engineering Department, 1969.

(2) The water supplying ability of the underlying water acquifer sources can sustain increased water withdrawal demand as the daily pump operating hours of the system during the cropping season is increased above 10 hours.

(3) Efficient field distribution of water at irrigation intensity levels below saturated condition is attainable at field situation. In the experiment positive grain yield levels were attained at irrigation intensities above 4 mm-depth/day. The 5 mm-depth/day treatment is the lowest irrigation level which could be included in the economic analysis. It is also the lowest treatment in which fair field water distribution is apparently obtained through the soil crack channels. It follows that better water distribution could be done at other irrigation levels investigated which are greater than 5 mm/day but are below saturated field condition.

3.1 The data

Economic analysis of pump irrigated farm project models was done using the following data:

(1) Rice yield-water use functional relationship. This was derived from the "water supply experiment" which was conducted at the IRRI experimental farm during the dry season of 1969. Estimation of rice yield and gross return expected at different irrigation intensity levels were based in this relationship. The result of the calculation is presented in Table 3.

(2) Estimated discharge capacities of 4-inch and 5-inch diameter shallow tubewell centrifugal pump and 10-inch diameter deepwell turbine pump systems.

TABLE 3. Estimated rice yield and gross returns per ha. at different irrigation intensity levels, dry season, 1969. [a]

Irrigation intensity (mm-depth per day)	Yield [b] (kgms/ha)	Gross return [c] (₱)
5	4,410	1,804.13
6	7,315	2,992.57
7	8,608	3,521.53
8	8,962	3,666.35
9.13	9,053	3,703.58

[a] Based from the results of field experiment, "Water Supply Experiment" conducted at the Agricultural Economics Department, IRRI, dry season, 1969.

[b] Computed from the logistic equation (Tintner method) fitted from the yield-water use data obtained from the field experiment.

[c] Based at ₱18 per cavan or ₱0.4091 per kgm. paddy.

These data are provided by Mr. Charles A. Robertson, Visiting Instructor of Agricultural Economics, UPCA, Laguna. Please refer to Table 4. The estimates were based from pump flow measurements made in three periods during the 1969 dry season in Nueva Ecija province.

Discharge capacities during the land preparation period was provided by the first round of measurements conducted in January. While those during the rest of the season were taken from the average of the two later rounds of measurements. For the shallow tubewell pump systems the acquifer sources can sustain higher water withdrawal rate during the start of the season. However, this rate gradually decreased due to lowering of water table toward the end of the season. As explained elsewhere the deepwell turbine pump systems tapped different layers of underground sources and water withdrawal rate could be maintained throughout the season.

(3) Average capital cost involved in putting up average models of pump irrigation systems. Table 5 shows estimates of cost for the following items: (a) pump and engine set, ,(b) well construction, and (c) structures and canals.

Pump and engine set - Cost quotations were obtained from farm machinery importers, dealers and distributors in Manila and suburbs. These were tabulated and the averages for the whole set, pump, engine and coupling pump to engine items were calculated. On the average, pump and engine set cost about ₱3,600, ₱5,000, and P52,000 for the 4-inch and 5-inch centrifugal and 10-inch turbine pump systems, respectively. The bulk of the cost is on the diesel engine prime mover which consist about 75% of the whole set for the centrifugal pump systems and about 50% for the turbine.

TABLE 4. Estimated discharge capacities of shallow tubewell centrifugal pump and deepwell turbine pump systems, 1969 dry season. [a/]

Systems	Discharge capacities	
	Transplanting time	Rest of the season
	(gpm)	
Shallow tubewell		
4" Ø	130	115
5" Ø	170	135
Deepwell		
10" Ø discharge	1500	1500

[a/] Discharge capacities for the systems are rough estimates provided by Mr. Charles A. Robertson, Visiting Instructor, UPCO, Graduate Program, UPCA, Laguna.

TABLE 5. Average capital costs involve in shallow tubewell centrifugal pump and deepwell turbine pump systems, 1969.[a]

Items	Shallow tubewell 4" Ø	Shallow tubewell 5" Ø	Deepwell 10" Ø
(1) Pump & Engine set[b]	₱3,579.00	₱4,978.00	₱52,500.00
a. Pump set	₱834.50	₱956.00	₱24,333.00
b. Engine	2,494.50	3,722.00	28,167.00
c. Coupling pump to engine	250.00	300.00	-
(2) Well construction[c]	1,555.00	2,243.34	36,584.16
(3) Structures & canals[d]	300.00	300.00	9,000.00
Total	5,434.00	7,521.34	98,084.16

a/ Sources of data: Delta Equipment & Parts, Inc.; Clindisco (Phil.) Inc.; Unel's Machinery Supply; Pacific Star Inc.; G.A. Machineries Inc.; E.R. Angeles Machinery Enterprises; Marsteel Corporation; SEA Commercial Company Inc.; Warner, Barnes & Co., Ltd.; Quinzy - Pacific Machinery Sales, Inc.; Atkins, Kroll & Co. Inc.; J. V. Hoover & Co. Inc.; Shamrock Well-Drilling Enterprises, Inc.; Wells and Pumps Inc.; Lopez, Emiliano Well Driller; I.C. de Guzman Well Drilling Enterprise; and author's interview notes (1968 & 1969).

b/ In the case of the centrifugal pump and engine sets, the costs of the pump set or engine of different brands were obtained. Cost of either the pump set or engine is calculated from the equation:

$C = P + E + \text{Coupling cost}$ where: C = Cost of pump & engine set
P = Cost of pump set
E = Cost of engine

For the deepwell, the cost of coupling is included in the engine cost.

c/ Well construction costs for the shallow tubewells are computed based on quotations of local well drillers and a well model as synthesized from records of the ISU and interview notes in Central Luzon, 1968 & 1969.

For the deepwell, construction cost was based from quotations of 5 well-drilling enterprises and a telescopic deepwell model as synthesized from records of dug deepwells.

d/ These are estimated figures based from interview notes of the author. For the small projects, only a small house for the pump and engine unit and minimum field ditches were constructed. For the deepwell this usually is composed of the pump and engine house, stilling tank and delivery canals within the system.

There is a wide range in the cost of the sets since varied pump specifications allow a range of power requirement for the prime mover. For the centrifugal pumps the 4-inch could be driven by a 5-10 horse power engine and the 5-inch by a 10-15 horse power engine. While the 10-inch turbine pump could be driven by a 90-145 horse power diesel engine.

Well construction - Evaluation of this was done by synthesizing average models for shallow tubewells and telescopic deepwell. Cost quotations for materials and drilling operations were then used to estimate the cost of constructing the models. Interview notes in Nueva Ecija in 1968 and 1969 and dug well data obtained from ISU and well drilling companies provide guidance in the synthesis of the well models. These are presented in the Appendix Figs. (1) and (2) and are reasonable average of wells one would construct in Nueva Ecija at present and in the near future. Average cost quotations for charged expenses on drilling were likewise shown in Appendix Table (1). The average cost of construction for the well models were calculated and presented in Appendix Tables (2) and (3) for shallow tubewells and telescopic deepwell respectively. With 1969 prices construction of average shallow tubewells would cost about ₱1,550 for 4-inch and ₱2,250 for 5-inch. While it would cost about ₱36,600 for a deepwell.

Structures and canals - This consist a smaller fraction in the cost of construction and installation of pump irrigation systems. Conservative estimates placed this at ₱300 average for the 4-inch and 5-inch centrifugal pump systems. Out of this amount are constructed a small house or shed of light materials for the pump and engine and a minimum of field ditches. Average cost for structures and canals for 10-inch turbine pump system is estimated at ₱9,000. This is used in constructing a semi-permanent pump and engine house, stilling basin and delivery canals and field ditches within the farm project.

3.2 The pump irrigated farm project models

Farm project models irrigated by the centrifugal and turbine types of pump systems were organized and designed. The models are shown in Table 6.

For each type of system four sets of farm models were developed. To specify the farm models, the farm hectarages were computed based from specified fixed pump system daily water delivery capabilities during the cropping season period and land preparation period and the water duties required by the irrigation intensity levels. During the cropping season period, the systems delivery capabilities are determined by the pump discharge capacity and the pump capacity levels of operation as indexed by the specified maximum daily operating hours (figures in parenthesis). These capacity levels were varied from 10 hours a day of operation in Set I up to full capacity operation in Set IV which was arbitrarily assumed at 20 hours for the centrifugal systems and 24 hours for the turbine system. During the land preparation period however, the pump system daily delivery capability was fixed for each type of system.

The fixed pump system delivery capabilities during the cropping season period were applied at five irrigation input levels ranging from 5 mm-depth/day (below saturated field condition) to about 9 mm-depth/day (continuously flooded situation) taken at 1 mm-depth/day interval. The ratios of the delivery capabilities to the water duties required by the irrigation levels provide initial estimates of the

TABLE 6. Hectarage of farm project models irrigated by different type of pump systems and operated at various maximum daily duration during the cropping season.

Project set/ irrigation input[a]	Types of Pump Systems					
	4" Ø S.T.W. centrifugal		5" Ø S.T.W. centrifugal		10" Ø D.W. turbine	
	Hrs.[b]	Hectares	Hrs.[b]	Hectares	Hrs.[b]	Hectares
	(10)		(10)		(10)	
I/5	10	5.223	10	6.132	10	68.135
6	10	4.315	10	5.110	10	56.779
7	10	3.731	10	4.380	10	48.668
8	10	3.264	10	3.832	10	42.584
9.13	10	2.860	10	3.358	10	37.314
	(14)		(14)		(14)	
II/5	11.55	6.033	12.89	7.905	12.30	83.72
6	13.86	6.033	14.00	7.153	14.00	79.48
7	14.00	5.223	14.00	6.131	14.00	68.13
8	14.00	4.570	14.00	5.365	14.00	59,61
9.13	14.00	4.004	14.00	4.701	14.00	52.23
	(18)		(18)		(18)	
III/5	11.55	6.033	12.89	7.905	12.30	83.72
6	13.86	6.033	15.47	7.905	14.75	83.72
7	16.17	6.033	18.00	7.883	17.20	83.72
8	18.00	5.876	18.00	6.898	18.00	76.646
9.13	18.00	5.148	18.00	6.044	18.00	67.160
	(20)		(20)		(24)	
IV/5	11.55	6.033	12.89	7.905	12.30	83.72
6	13.86	6.033	15.47	7.905	14.75	83.72
7	16.17	6.033	18.05	7.905	17.20	83.72
8	18.48	6.033	20.00	7.664	19.66	83.72
9.13	20.00	5.721	20.00	6.716	22.44	83.72

[a] mm-depth of water per day.
(Hrs.) maximum daily operating hours during the cropping season.

[b] Actual daily operating hours for the specified farm situation in the farm models.

farm model hectarages. These estimates were then checked if within the capability of the system to service during the land preparation period. If they could be serviced, then the initial estimates could be taken as the farm model hectarages under the specified type of system, pump capacity levels of operation and irrigation intensity levels. If not, the maximum hectarage that could be serviced by the system during the land preparation period will be taken as an estimate for the specified models.

Based on this scheme the hectarage of each farm model was calculated as illustrated in Appendix B. The calculations were done based on the following assumptions:

(a) During the land preparation period the pump systems will operate daily and finish up the operation within a maximum period of 20 days. During this period the centrifugal pump systems will run at 20 hours a day and the turbine pump system 24 hours. Also, within the land preparation period the field water losses due to evaporation, seepage and percolation will be estimated at 6 mm-depth/day.

(b) The land preparation puddling operation for a definite field portion within a farm will be done in two consecutive days. Here, it is further assumed that machinery is available to start plowing and puddling operations as soon as the field is saturated and enough depth of water was applied for satisfactory operation.

(c) During the cropping season period the pump system will operate daily. The farm hectarage will be divided into five equal portions and irrigated at 5 days rotation until crop maturity.

It will be noted in Table 6 that as the pump system operation approaches full capacity (set IV farm models) by extending the pumping hours, a maximum farm hectarage is reached particularly at lower irrigation intensity levels. This is the maximum hectarage that the system could service during the land preparation period, hence, the maximum hectarage that could be planted at the start of the season.

As explained elsewhere the initial estimate for the farm model hectarage is calculated as the ratio of the system's daily delivery capability during the cropping season to the daily water duty required by the irrigation level. If we take the case of a farm model which is irrigated at a certain level of intensity and increase the system's delivery capability during the cropping season by extending the pumping hours, the initial estimate of the model hectarage will definitely increase since the water duty stays constant. If the irrigation level is low as 6 mm-depth/day for example, at certain pump capacity level of operation this initial estimate exceeded the maximum hectarage that could be serviced during the land preparation period under all types of systems investigated. Hence, under the above conditions the maximum hectarage that could be planted at the start of the season was taken as an estimate of the farm model hectarage. On the other hand, if the irrigation level is high as the continuously flooded situation (9.13 mm-depth/day), even if the systems are operated at full capacity the initial estimate of farm hectarage could be less than what could be planted at the start of the season. The initial estimate in this case could be taken as the farm model hectarage. This was observed with the centrifugal pump systems which draw up water from shallow tubewells. It is a physical limitation due to decreased discharge capacities during the cropping season period. For the deepwell turbine pump system, however, the pump discharge capacity is assumed maintained throughout the production period. In this case, the pump capability at full capacity operation during the cropping season period yielded enough water to satisfy the water duty demanded by the maximum hectarage that could be planted at the start of the season even if irrigated at the flooded situations.

3.3 Cost and return farm budgets

Using information in the preceding sections, budgets on cost and returns involved in the production of a dry season lowland rice crop at the different pump irrigated farm project models were prepared. The cost items consisted of the following:

(a) pump system's operational expenses
(b) charges on the use of irrigation facilities
(c) farm production cost

The pump system's operational expenses is the total cash expected to put the system in operation during the season. This is proportional to the total pump running hours incurred in the season as demanded at the different irrigation intensity levels at the farm models. This item is further broken down into pump and engine operational cost and maintenance of structures which are presented in Table 7. The former is on a per hour basis and the latter is estimated for the whole system during the season. To compute pump and engine operational expenses for the whole season the pump operating hours during the land preparation and cropping season periods were estimated for each model. These estimates are presented in Appendix

TABLE 7. Average operational cost per hour of shallow tubewell centrifugal pump and deepwell turbine pump systems, 1969.[a]

Items	Shallow tubewell 4" Ø	Shallow tubewell 5" Ø	Deepwell 10" Ø
Operator's wage	₱ 0.50	₱0.50	₱0.75
Fuel consumption[b]	0.3000	0.38748	4.3200
Oil consumption[c]	0.0240	0.0522	0.4920
Servicing & maintenance[d]	0.0415	0.0415	0.0550
Overhaul[e]	0.0295	0.0295	0.0800
Replacement cost[f]	0.0312	0.0465	0.3520
Maintenance of structures[g]	15.00	15.00	450.00
Total: (Excluding maintenance of structures)	0.9262	1.05718	6.049

[a] Source of data: Pacific Star Inc.; Delta Equipment & Parts Inc.; Warner, Barnes & Co. Ltd.; SEA Commercial Co. Inc.; Marsteel Corporation; E.R. Angeles Machinery Enterprises and G.A. Machineries Inc.

[b] Evaluated at ₱0.18/liter cost of diesel fuel.

[c] Evaluated at ₱1.50/liter of S.A.E. 30 lubricating oil light duty and ₱2.05/liter for heavy duty type.

[d] Based from servicing & maintenance every 2000 hours of operation.

[e] Based from overhauling at 4000 running hours.

[f] Usually based at 5% of initial cost of engine at 4000 hours.

[g] Based on 5% of cost of structures. Figures are for whole season of operation, assuming that the system will be used for the dry season only.

Table 4. The calculation procedure is illustrated in Appendix C. The pump running hours during the land preparation period is a function of the farm model hectarage while during the cropping season it is related to farm hectarage, irrigation input applied and crop season irrigation period.

The second cost item is an estimate of a fixed repayment schedule for using the system's facilities for six months cropping period. This is constant for each type of system as worked out in Table 8.

The last cost estimate is shown in Table 9 and expressed as expenses per hectare. This is the total expenses involved in farm field operations and payment for the use of the land. These farm costs directly vary with the farm model hectarage.

Estimates for farm gross returns were made based on the logistic functional relationship between rice yield and irrigation input. Estimations on the per hectare basis at different irrigation intensity levels are presented in Table 3. These are then translated to farm basis thru direct conversion from the farm model hectarage.

Finally, the cost and return budgets were prepared for each of the farm project models. These are summarized in Tables 10, 11, and 12 for farm models irrigated by the 4-inch and 5-inch centrifugal and 10" turbine pump systems respectively.

3.4 Economic measures

Net farm returns[14/] and capital repayment feasibility ratio (R) at the different farm project models were evaluated from the farm cost and return budgets.

[14/] Net farm return and farm income are interchangeably used in this paper.

TABLE 8. Interest and depreciation charges for facilities of different types of pump project models, dry season, 1969.[a]

Items	Shallow tubewell		Deepwell
	4" ∅	5" ∅	10" ∅
	(₱)	(₱)	(₱)
Pump and Engine			
(1) Interest[b]	214.740	298.68	3,150.00
(2) Depreciation[c]	305.074	424.325	4,475.10
Well			
(1) Interest	93.300	134.60	2,195.05
(2) Depreciation	80.595	116.272	1,896.157
Structures & Canals			
(1) Interest	18.00	18.00	540.00
(2) Depreciation	15.55	15.55	466.47
Total	727.26	1,007.43	12,722.78

[a] Evaluated for a period of six months.

[b] Based at 6% interest rate.

[c] Evaluated at 3 1/2% earning rate for sinking fund depreciation at 10 years life with zero salvage value for pump and engine and 15 years life with zero salvage value for well and structures.

TABLE 9. Farm production cost per ha. of rice at high management level. Dry season, 1969 prices.*

Expenses	Costs (₱)
(1) Seeds (1 cavan of improve variety)	40.00
(2) Weedicide (2, 4-D)	15.00[a/]
(3) Insecticide (3 applications of Diazinon at 2 kgm ai per application)	156.00
(4) Fertilizer (100 kgm N using $(NH_4)_2SO_4$)	132.00
(5) Land preparation	120.00[a/]
(6) Labor for applying insecticide & herbicides	28.00[a/]
(7) Seedbed	25.00[a/]
(8) Transplanting in straight rows	80.00
(9) Handweeding (twice at ₱60.00 @)	120.00
(10) Harvesting & threshing (15.0% of harvest at ₱18.00 per cavan)	-
(11) Land rental	200.00[a/]
Total (excluding item no. 10)	916.00

* Costs other than those labelled a/ are estimated using current charges prevalent in Laguna.

a/ Source: Sorenson, R. and E. L. Felton, Jr. 1967. Seed Corporation of the Philippines: A Case Study, a paper presented at the Seminar-Workshop on the Economics of Rice Production, IRRI, Dec. 8 - 9, 1967.

TABLE 10. Costs and returns at different farm project models irrigated by a 4" ∅ S. T. W. centrifugal pump system which is operated at various maximum daily duration during the cropping season.

Project set/ irrigation input	Hectarage	Farm costs		Charges on capital[b]	Gross farm returns[a]
		Pump system operation	Farm operations[a]		
(mm/day)	(has.)		(₱)		(₱)
I/5	5.223	1385.05	4784.27	727.26	8009.52
6	4.315	1257.96	3952.54	727.26	10976.00
7	3.731	1172.75	3417.60	727.26	11168.00
8	3.264	1107.18	2989.82	727.26	10171.92
9.13	2.860	1078.74	2619.76	727.26	9003.40
II/5	6.033	1615.47	5526.23	727.26	9251.67
6	6.033	1797.94	5526.23	727.26	15346.03
7	5.223	1672.90	4784.27	727.26	15634.02
8	4.570	1562.68	4186.12	727.26	14241.95
9.13	4.004	1522.85	3667.66	727.26	12604.77
III/5	6.033	1615.47	5526.23	727.26	9251.67
6	6.033	1797.94	5526.23	727.26	15346.03
7	6.033	1958.02	5526.23	727.26	18058.60
8	5.876	2046.16	5382.42	727.26	18311.98
9.13	5.148	1974.84	4715.57	727.26	16206.13
IV/5	6.033	1615.47	5526.23	727.26	9251.67
6	6.033	1797.94	5526.23	727.26	15346.03
7	6.033	1958.02	5526.23	727.26	18058.60
8	6.033	2097.10	5526.23	727.26	18801.23
9.13	5.721	2224.91	5240.44	727.26	18009.95

[a] Exclude harvester's share.

[b] Evaluated for six months.

TABLE 11. Costs and returns at different farm project models irrigated by a 5" Ø centrifugal pump system which is operated at various maximum daily duration during the cropping season.

Project set/ irrigation input	Hectarage	Farm costs		Charges on capital[b/]	Gross farm returns[a/]
		Pump system operation	Farm operation[a/]		
(mm/day)	(has.)		(₱)		(₱)
I/5	6.132	1522.01	5616.91	1007.43	9403.48
6	5.110	1413.78	4680.76	1007.43	12998.22
7	4.380	1318.50	4012.08	1007.43	13110.65
8	3.832	1232.45	3510.11	1007.43	11942.03
9.13	3.358	1215.32	3075.93	1007.43	10571.13
II/5	7.905	2004.61	7240.98	1007.43	12122.41
6	7.153	2014.13	6552.15	1007.43	18194.95
7	6.131	1860.31	5615.99	1007.43	18351.94
8	5.365	1740.32	4914.34	1007.43	16719.49
9.13	4.701	1700.14	4306.12	1007.43	14798.96
III/5	7.905	2004.61	7240.98	1007.43	12122.41
6	7.905	2236.87	7240.98	1007.43	20107.80
7	7.883	2434.88	7220.83	1007.43	23596.20
8	6.898	2257.49	6318.57	1007.43	21496.93
9.13	6.044	2206.01	5536.30	1007.43	19026.78
IV/5	7.905	2004.61	7240.98	1007.43	12122.41
6	7.905	2236.87	7240.98	1007.43	20107.80
7	7.905	2441.23	7240.98	1007.43	23662.04
8	7.664	2543.77	7020.22	1007.43	23884.07
9.13	6.716	2462.37	6151.86	1007.43	21142.25

[a/] Exclude harvester's share.

[b/] Evaluated for six months.

TABLE 12. Costs and returns at different farm project models irrigated by a 10" Ø D.W. turbine pump system which is operated at various maximum daily duration during the cropping season.

Project set/ irrigation input	Hectarage	Farm costs		Charges on capital[b/]	Gross farm returns[a/]
		Pump system operation	Farm operation[a/]		
(mm/day)	(has.)		(₱)		(₱)
I/5	68.135	9,787.85	62,411.66	12,722.78	104,485.74
6	56.779	8,950.65	52,009.56	12,722.78	144,427.86
7	48.668	8,235.06	44,579.89	12,722.78	145,677.95
8	42,584	7,697.91	39,006.94	12,722.78	132,708.67
9.13	37,314	7,574.51	34,179.62	12,722.78	117,466.07
II/5	83.72	11,909.83	76,687.52	12,722.78	128,385.57
6	79.48	12,572.20	72,803.68	12,722.78	202,171.80
7	68.13	11,509.99	62,407.08	12,722.78	203,933.73
8	59.61	10,793.79	54,602.76	12,722.78	185,768.66
9.13	52.23	10,494.36	47,842.68	12,722.78	164,422.38
III/5	83.72	11,909.83	76,687.52	12,722.78	128,385.57
6	83.72	13,168.02	76,687.52	12,722.78	212,957.27
7	83.72	14,278.01	76,687.52	12,722.78	250,599.12
8	76.646	13,909.02	70,207.74	12,722.78	238,859.40
9.13	67.160	13,483.17	61,518.56	12,722.78	211,422.56
IV/5	83.72	11,909.83	76,687.52	12,722.78	128,385.57
6	83.72	13,168.02	76,687.52	12,722.78	212,957.27
7	83.72	14,278.01	76,687.52	12,722.78	250,599.12
8	83.72	15,245.85	76,687.52	12,722.78	260,904.80
9.13	83.72	16,927.48	76,687.52	12,722.78	263,554.16

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a/ Exclude harvester's share.

b/ Evaluated at six months.

The results are summarized in Tables 13, 14 and 15 for farm projects irrigated by the three types of pump systems.

Net farm returns is a straight forward measure of the profitability of producing rice under alternative situations at the pump irrigated farm projects. It gave an indication on the relative advantages in producing rice under varied levels of irrigation input. Likewise, it is a measure of evaluating the benefits in attempting to operate the systems toward full capacity.

Capital repayment feasibility ratio (R) is evaluated from the following formula:

$$R = \frac{(B - F.O.C. - P.O.C.)}{K}$$

where:

R = capital repayment feasibility ratio

B = gross farm return

F.O.C. = farm production cost

P.O.C. = pump system operational cost

K = charges for use of irrigation facilities

This measure is an indication of whether under different farm situations enough production could be obtained to generate farm returns that will cover up operational expenses and still leave enough for paying amortization cost and farm income. Maximizing R is important as a measure of the degree of certainty by which the existing system could be replaced after its useful life. An R value greater than unity denotes ability to pay and positive farm income. And since net farm return is evaluated above all costs (including charges for the use of facilities) positive

TABLE 13. Farm returns above total cost at different farm project models irrigated by 4" Ø S. T. W. centrifugal pump system which is operated at various maximum daily duration during the cropping season.[a]

Farm project specifications				
Project set/ irrigation input	Hectarage	Operating hours[b]	Farm returns[c]	R[d]
(mm/day)	(has.)	(10)	(₱)	
I/5	5.223	10	1112.94	2.53
6	4.315	10	5038.26	7.93
7	3.731	10	5850.40	9.04
8	3.264	10	5347.67	8.35
9.13	2.860	10	4577.64	7.29
		(14)		
II/5	6.033	11.55	1382.71	2.90
6	6.033	13.86	7294.60	11.03
7	5.223	14.00	8449.59	12.62
8	4.570	14.00	7765.89	11.68
9.13	4.004	14.00	6687.00	10.19
		(18)		
III/5	6.033	11.55	1382.71	2.90
6	6.033	13.86	7294.60	11.03
7	6.033	16.17	9847.09	14.54
8	5.876	18.00	10156.14	14.96
9.13	5.148	18.00	8788.46	13.08
		(20)		
IV/5	6.033	11.55	1382.71	2.90
6	6.033	13.86	7294.60	11.03
7	6.033	16.17	9847.09	14.54
8	6.033	18.48	10450.64	15.37
9.13	5.721	20.00	9817.34	14.50

Table 13 (cont'd.)

a/ Calculations are adopted from results of cost and return farm budgets for different farm project models.

b/ Figures enclosed in parenthesis are the system's specified maximum daily operating hours during the cropping season for each set of farm models. While the indicated operating hours are the actual for the specified farm situation in the models.

c/ Net above total cost.

d/ Computed from the formula:

$$R = (B - F.O.C. - P.O.C.)/K$$

where: R = capital repayment feasibility ratio
B = gross farm return
F.O.C. = farm production cost
P.O.C. - Pump system operational cost
K = charges for use of irrigation facilities

TABLE 14. Farm returns above total cost at different farm project models irrigated by a 5" Ø S. T. W. centrifugal pump system which is operated at various maximum daily duration during the cropping season.[a]

Farm project specification				
Project set/ irrigation input	Hectarage	Operating hours[b]	Farm returns[c]	R[d]
(mm/day)	(has.)	(10)	(₱)	
I/5	6.132	10	1257.13	2.25
6	5.110	10	5896.28	6.85
7	4.380	10	6772.64	7.72
8	3.832	10	6192.05	7.15
9.13	3.358	10	5272.44	6.23
		(14)		
II/5	7.905	12.89	1869.39	2.86
6	7.153	14	8621.24	9.56
7	6.131	14	9868.21	10.80
8	5.365	14	9057.40	9.99
9.13	4.701	14	7785.27	8.73
		(18)		
III/5	7.905	12.89	1869.39	2.86
6	7.905	15.47	9622.52	10.55
7	7.883	18	12933.06	13.84
8	6.898	18	11913.44	12.82
9.13	6.044	18	10277.04	11.20
		(20)		
IV/5	7.905	12.89	1869.39	2.86
6	7.905	15.47	9622.52	10.55
7	7.905	18.05	12972.40	13.88
8	7.664	20.00	13312.65	14.21
9.13	6.716	20.00	11520.59	12.44

Table 14 (cont'd).

a/ Calculations are adopted from results of cost and return farm budgets for different farm project models.

b/ Figures enclosed in parenthesis are the system's specified maximum daily operating hours during the cropping season for each set of farm models. While the indicated operating hours are the actual for the specified farm situation in the models.

c/ Net above total cost.

d/ Computed from the formula:

$$R = (B - F.O.C. - P.O.C.)/K$$

where:

R = capital repayment feasibility ratio
C = gross farm return
F.O.C. = Farm production cost
P.O.C. = Pump system operational cost
K = Charges for use of irrigation facilities

TABLE 15. Farm returns above total cost at different farm project models irrigated by a 10" Ø D.W. turbine pump system which is operated at various maximum daily duration during the cropping season.[a]

Farm project specification				
Project set/ irrigation input	Hectarage	Operating hours[b]	Farm returns[c]	R[d]
(mm/day)	(has.)	(10)	(₱)	
I/5	68.135	10	19,563.42	2.54
6	56.779	10	70,745.18	6.55
7	48.668	10	80,140.20	7.30
8	42.584	10	73,281.15	6.75
9.13	37.314	10	62,989.05	5.95
		(14)		
II/5	83.72	12.30	27,065.44	3.12
6	79.48	14.00	104,073.14	9.17
7	68.13	14.00	117,293.88	10.22
8	59.61	14.00	107,649.33	9.45
9.13	52.23	14.00	93,362.56	8.33
		(18)		
III/5	83.72	12.30	27,065.44	3.12
6	83.72	14.75	110,378.95	9.68
7	83.72	17.20	146,910.81	12.52
8	76.646	18.00	142,019.86	12.11
9.13	67.160	18.00	123,698.05	10.70
		(24)		
IV/5	83.72	12.30	27,065.44	3.12
6	83.72	14.75	110,378.95	9.68
7	83.72	17.20	146,910.81	12.52
8	83.72	19.66	156,248.65	13.28
9.13	83.72	22.44	157,216.38	13.55

Table 15 (cont'd).

a/ Calculations are adopted from results of cost and return farm budgets for different farm project models.

b/ Figures enclosed in parenthesis are the system's specified maximum daily operating hours during the cropping season for each set of farm model. While the indicated operating hours are the actual for the specified farm situation in the models.

c/ Net above total cost.

d/ Computed from the formula:

$$R = (B - F.O.C. - P.O.C.)/K$$

where:

R = capital repayment feasibility ratio
B = gross farm return
F.O.C. = Farm production cost
P.O.C. = Pump system operational cost
K = Charges for use of irrigation facilities

net farm returns is an assurance of amortization payment. Hence, the two economic measures above are maximized at identical farm situation.

3.5 Results of the analysis

For each type of pump systems farm income and capital repayment feasibility at the different farm projects varied with the following factors.

(1) With respect to irrigation input under different levels of pump capacity operation.

(2) With respect to pump capacity operation under varied irrigation input levels.

(3) With respect to combinations of pump capacity operation and irrigation input.

These changes in the two economic measures are illustrated in Figures 4, 5, and 6 for the 4-inch and 5-inch centrifugal pump and 10-inch turbine pump systems, respectively.

With respect to irrigation input, maximization of farm income and the ratio R is arrived at about 7 mm/day when the systems are operated at pump capacities below the arbitrary full capacity specifically from 10 to 18 hours of daily operation during the cropping season. This is observed for all the systems except for the 4-inch centrifugal pump. In this system the economic measures were maximized at 8 mm/day when the system is operated at 18 hrs/day maximum. As noted earlier, at 7 mm/day the crop is subjected to below flooded field condition while at 8 mm/day the crop is subjected to practically shallow flooded situation during the entire cropping season.

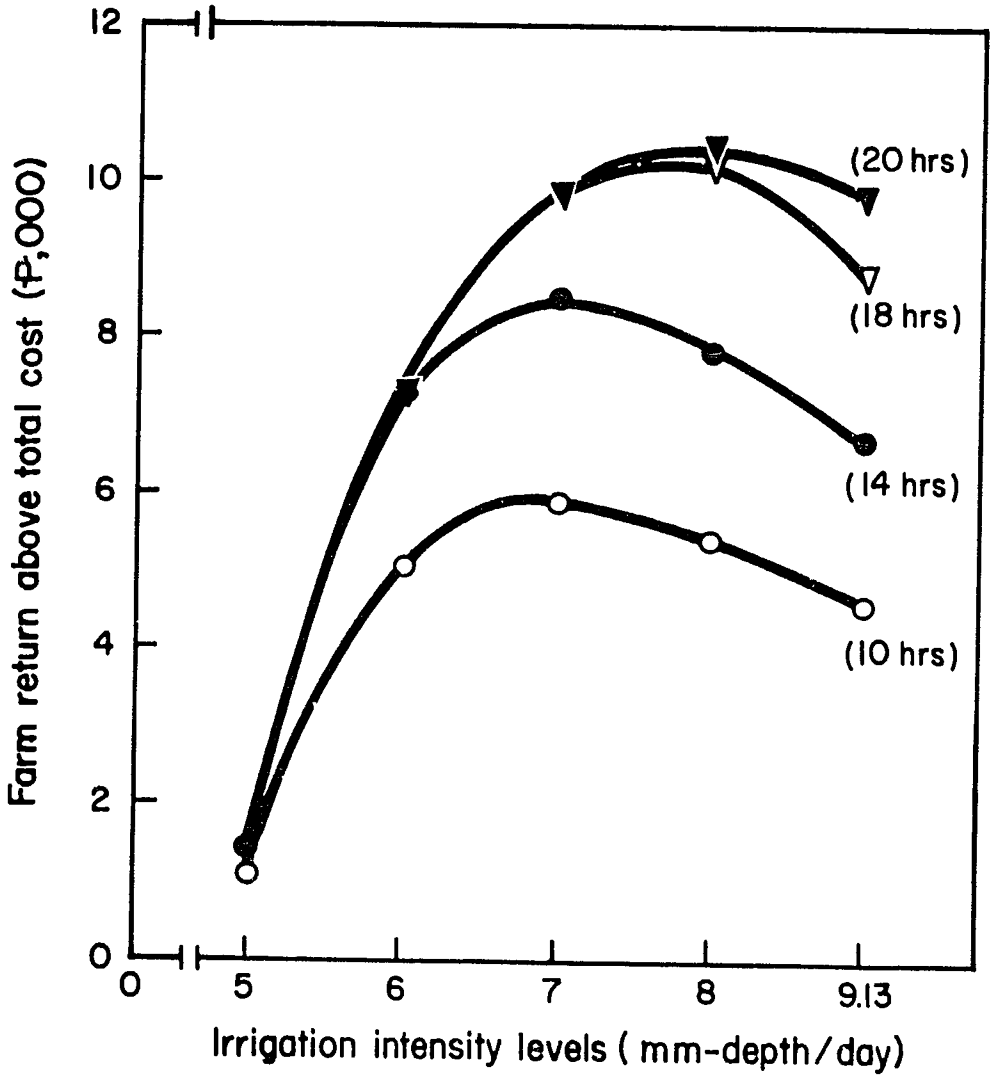

Fig. 4. Net farm returns at different farm project models irrigated by a 4" ∅ S. T. W. centrifugal pump system and operated at various maximum daily duration during the cropping season, dry season, 1969.

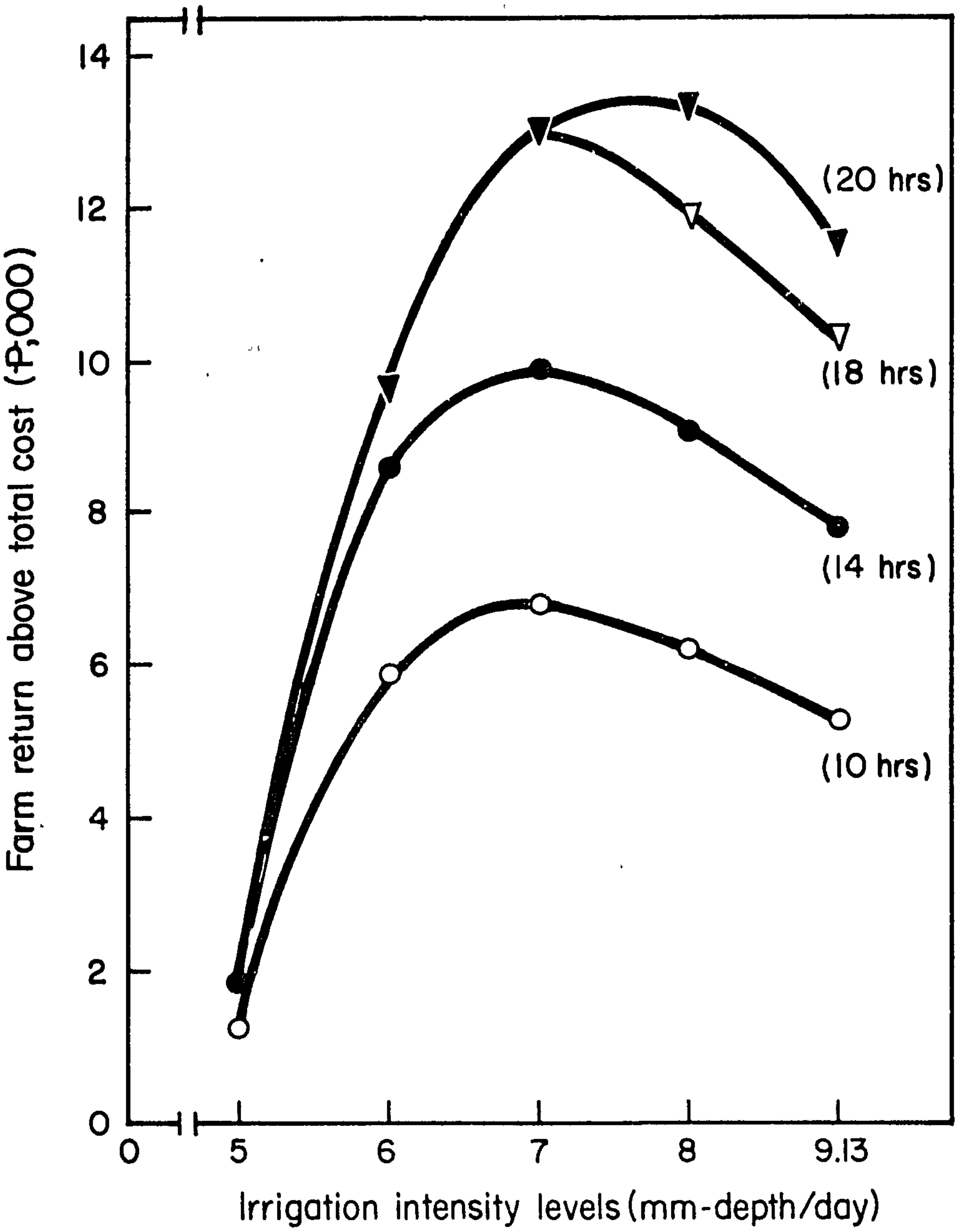

Fig. 5. Farm returns above total cost at different farm project models irrigated by a 5" ∅ S. T. W. centrifugal pump system and operated at various maximum daily duration duration during the cropping season, dry season, 1969.

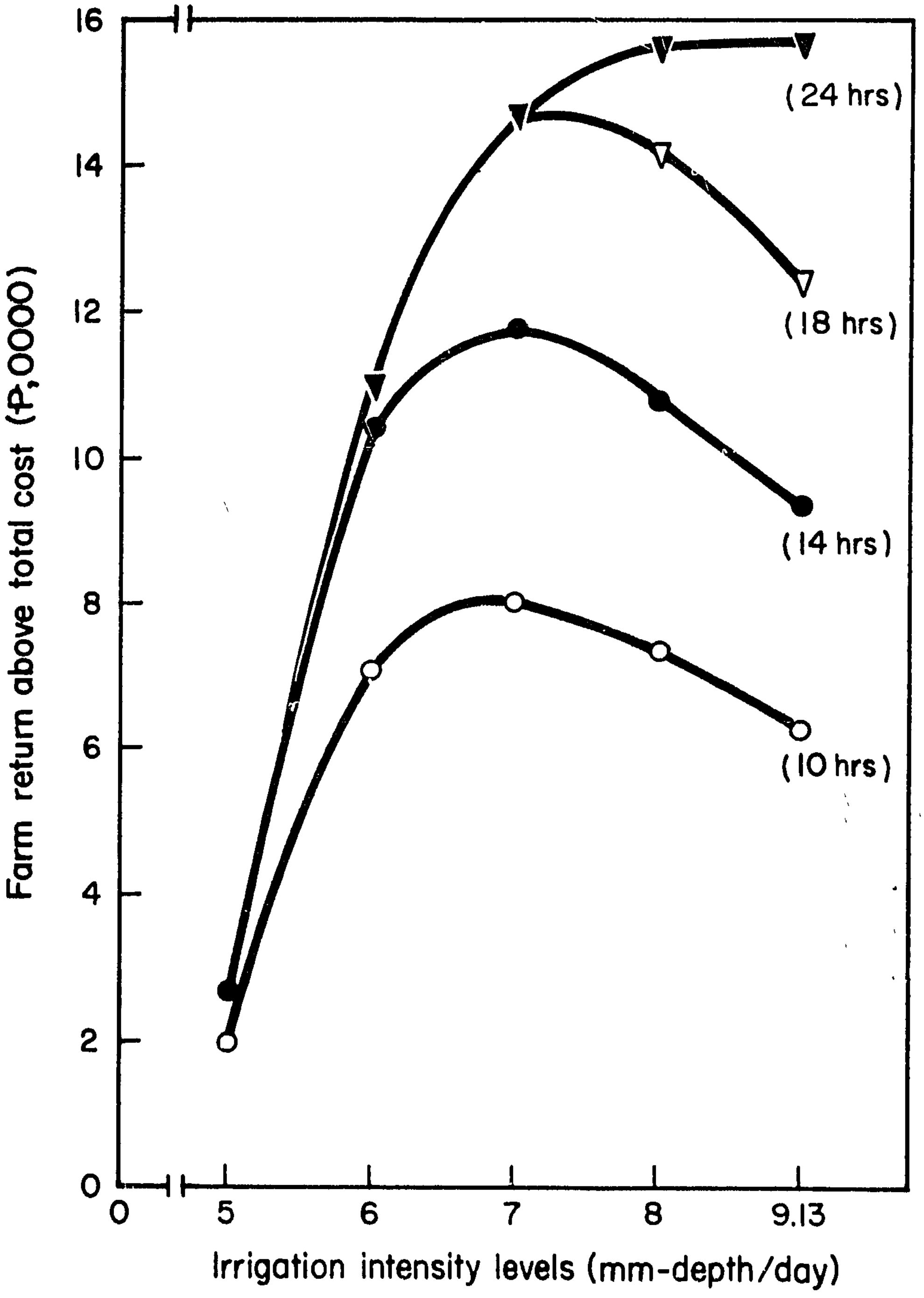

Fig. 6. Farm returns above total cost at different farm project models irrigated by a 10" Ø D. W. turbine pump systems and operated at various maximum daily duration during the cropping season, dry season, 1969.

The above observation support in part the second hypothesis of this study. For the 5-inch centrifugal and 10-inch turbine pump systems the limited irrigation delivery capabilities at low levels of pump operation capacities provide water to a limited hectarage under flooded situation with high productivity. High productivity under limited farm hectarage at this irrigation level did not maximize farm income and the ratio R. With these farm situations the farmer will be better off to put into production a larger hectarage by lowering the water input.

The 4-inch diameter centrifugal pump system operating at 18 hours a day yielded sufficient water under shallow flooded condition (8 mm/day) to generate farm returns which maximized ability to pay charges for facility use and farm income. This result confirms the following observation: results of studies[15] conducted by one firm showed a better economic performance for the 4-inch size over other bigger sizes of centrifugal pumps. There is a tendency among irrigation pump sellers to scrap off the 5-inch centrifugal pump in their line of sales.

Subjecting the crop to deeper flooding continuously during the cropping season (at 9.13 mm/day irrigation level) did not maximize farm income and the ratio R even if the systems were operated at full capacity. Increased productivity in going from the shallow flood to the deeper flood situation at full pump capacity operation entails lower added farm returns against higher added cost. Under full pump capacity operation, farm income and the R ratio are maximized at the shallow flood condition.

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[15] Personal communication with Mr. Felipe Mateo, Gami Machinery Enterprises, Valenzuela, Bulacan, 1969.

These results indicate that under current price estimates if water economy is the only consideration at farms served by pump irrigation systems it is definitely not profitable to produce rice under continuously deep flooded situation (at or above 9.13 mm/day irrigation level). Likewise, in cases where the water sources are limiting and the system's operation is limited to low pump capacity levels it is better to produce rice under irrigation levels below the flooded situation to maximize benefits in rice production. On the other hand, if it is possible to operate the system at full capacity it is advisable to produce rice under the shallow flood situation.

4.0 CONCLUDING REMARKS

This paper tried to establish a suitable rice yield-water input functional relationship that could be used in an economic analysis of different pump irrigated farm project models. It attempts to resolve the issues of maximization of farm income and capital repayment ability at alternative farm situations served by pump irrigation systems. It also attempts to investigate some questions involving under-utilization of pump systems and gave indication on the profitability of lengthening the system's operating hours. The farm cost and return budgets made in the study could also help in deciding what type of system is needed at particular farm situations.

However, the above analysis should be qualified according to the following restrictions:

The most critical source of variation in the result of the analysis is the yield-water use functional relationship. Though the nature of the relationship may hold, the rate of change in yield with respect to water input is expected to be low at actual farm level situations depending on rice variety, soil and environmental conditions and level of management. Some changes are also expected in the estimation of farm costs for weeding and insecticide material and its application. For the 7 mm-depth per day and at the flooded irrigation levels these might not be pronounced. But for the lower irrigation levels these would add significant amount to costs.

Interpretation should consider these aspects to judge the appropriateness of extending the analysis to particular situations. By and large a more complete analysis could be made if the following information are available in appropriate forms for various farm level situations:

(a) Rice yield-water use relationships for the wet and dry seasons.

(b) Supplemental irrigation needed during the wet season. This will involve probability analysis on amount and occurrence of effective rainfall.

(c) Ground water resource information. This will help in deciding up to what extent systems pump capacities could be raised.

(d) Additional information on the construction and operation of irrigation reservoirs. This is still an unpopular idea in the Philippines.

APPENDIX A

Calculation of the values of the parameters in the equation model of the form:

$$Y_t = \frac{K}{1 + be^{-at}} \qquad (1)$$

(1) The relationship, $Z_t + 1 = A + BZ_t$ where: (2)

$Z_t = \frac{1}{Y_t}$ and t = 1 for 4.5 mm-depth/day irrigation level, t = 2 for 5.00 mm/day down to t = 9 for 8.5 mm/day.

was analyzed using the simple linear regression technique.

The resulting equation is:

$$Z_t = 5.7591 \times 10^{-5} + 0.477272\ Z_t$$

This result was used in calculating the values of the parameters of equation (1).

(2) K was obtained from the formula:

$$K = (1 - B)/A \qquad (3)$$

$$= (1 - 0.477272)/5.7591 \times 10^{-5}$$

$$= 9076.557 \text{ kgms/ha}$$

(3) $a = -\log_e B$ (4)

$$= -\log_e 0.477272 = - (-0.7397)$$

$$= 0.7397$$

Appendix A (cont'd)

(4) The value of parameter, b was computed using the method of Rhodes as:

$$\log_e B = \frac{a\,(n + 1)}{2} + \frac{1}{n} \sum_{t=1}^{9} \log e\left(\frac{K}{Y_t} - 1\right) \qquad (5)$$

$$= \frac{0.7397\,(9 + 1)}{2} + \frac{1}{9}\,(-17.3423)$$

$$= 3.698 - 1.927 = 1.771$$

$$b = \text{the anti-ln of } 1.771$$

$$= 5.8767$$

(5) The resulting equation from the above analysis is:

$$\hat{Y}_t = \frac{9076.557}{1 + 5.8767\, e^{-0.7397\, t}} \qquad (6)$$

This equation is then tested for closeness of fit by summing up residuals $(Y_t - \hat{Y}_t)$ within the range of Y_t values investigated. The expected result is $\Sigma(Y_t - \hat{Y}_t) \sim 0$. However, the results showed far from expected. At this point the constant of integration, b was manipulated to arrive at the closest fit. The result is:

$$\hat{Y}_t = \frac{9076.557}{1 + 4.65\, e^{-0.7397\, t}} \qquad (7)$$

$$R^2 = 0.99325$$

as presented

APPENDIX B

Calculation of the farm model hectarage.

For each farm project model set under each type of pump system the maximum operating hours which the system could operate during the cropping season period is indicated. To illustrate the calculation of the hectarage for a particular farm model, let us consider the following:

Take the case of the 4" Ø S. T. W. centrifugal pump system's project model set IV. During the land preparation period the system's discharge capacity is 130 gpm. It could operate at 20 hours a day maximum and the whole operation is assumed to be undertaken within 20 days. During the cropping season period the system's discharge capacity is lowered to 115 gpm and it could operate at 20 hours a day maximum. Furthermore, consider the case of the particular farm model which is irrigated at 9.13 mm/day level.

The calculations will be as follows:

(a) During the cropping season period, the pump system daily irrigation delivery capability is:

$$= \frac{115 \text{ gallons}}{\text{min.}} \times \frac{60 \text{ min.}}{\text{hr.}} \times \frac{20 \text{ hrs.}}{\text{day}} \times \frac{1 \text{ m}^3}{264.2 \text{ gallons}}$$

$$= 522.331 \ \frac{\text{m}^3}{\text{day}}$$

while 9.13 mm/day irrigation level will require a water duty of:

$$\frac{9.13 \text{ mm}}{\text{day}} \times \frac{1\text{m}}{1000 \text{ mm}} \times \frac{10{,}000 \text{ m}^2}{\text{ha}}$$

$$= \frac{91.3 \text{ m}^3}{\text{ha-day}}$$

Appendix B (cont'd).

such that the daily capability above could be distributed to:

$\frac{522.331}{91.3} = 5.721$ hectares. It should be ascertained if this hectarage could be serviced during the land preparation period.

(b) The maximum hectarage that could be planted at the start of the season is computed as follows:

The daily capability of the system during the land preparation period is:

$$= \frac{130 \text{ gallons}}{\text{min.}} \times \frac{60 \text{ min.}}{\text{hr.}} \times \frac{20 \text{ hrs.}}{\text{day}} \times \frac{1 \text{ m}^3}{264.2 \text{ gallons}}$$

$= 590.461 \text{ m}^3/\text{day}$

This capability is used during the land preparation period as follows:

(1) At the first day, soil saturate:

$\frac{590.461}{660} = 0.894$ hectare since 66 mm-depth of water or $660 \text{ m}^3/\text{ha}$ is needed for soil saturation.

(2) At the second day, finish up the land preparation operations for this 0.894 ha. field portion.

(3) At the third day:

(i) Replenish water loss of $(0.894)(60) = 53.640 \text{ m}^3/\text{day}$ since 6 mm/day is assumed as losses due to evaporation and field losses.

(ii) The effective capability of the system will be:

$= 590.461 - 53.640 = 536.821 \text{ m}^3/\text{day}$

(iii) Soil saturate additional field portion as:

$\frac{536.821}{660} = 0.813$ hectare

Appendix B (cont'd).

(4) At the fourth day:

(i) Finish up land preparation of 0.813 hectares.

(ii) This makes a total of 1.707 hectares prepared at the end of the fourth day.

(5) At the 5th day and succeeding days repeat the calculations done in (3) & (4).

:

: such that:

:

(19) At the 19th day:

(i) Replenish water loss of:

$$(5.653)\ (60) = 339.18\ m^3/day.$$

(ii) Effective system's capability:

$$590.461 - 339.18 = 251.281\ m^3/day$$

(iii) Soil saturate an additional area of:

$$\frac{251.281}{660} = 0.380 \text{ hectare}$$

(20) At the 20th day:

(i) Finish up 0.380 hectare

(ii) This completes a total of 6.033 hectares land prepared during the land preparation period.

(c) The 6.033 hectares that could be prepared and planted during the start of the season is much higher than what the system could service during the cropping

Appendix B (cont'd).

season period. Hence, 5.721 hectares as computed in (a) could be put into production under 9.13 mm/day irrigation level for this particular farm project model.

(d) Contrastingly, if we take the case of the farm model in the same set which is irrigated at 5 mm/day, the irrigation capability of the system during the cropping season could service: $\frac{522.331}{50} = 10.446$ hectares. This is much higher than what could be planted at the start of the season which is only 6.033 hectares. Such that the maximum possible hectarage this model could take is 6.033 hectares only.

APPENDIX C

Calculation of total pump operating hours.

Take the case of the above project model where the hectarage is 5.721 hectares and irrigated at 9.13 mm/day level. The calculation is as follows:

(a) During the land preparation period:

(1) At the end of the 18th day of operation the system was able to service a total of 5.653 hectares which is 0.068 hectare short of the farm model hectarage. Such that the operation has to be extended to the 19th and 20th day.

(2) At the 19th day:

(i) 339.18 m^3/day is needed to be replenished due to evaporation and field losses.

(ii) Additional requirement to soil saturate 0.068 hectare:

$(0.068)\ (660) = 44.88\ m^3$

(iii) Total irrigation requirement: 384.06 m^3

(3) Compute the no. of hours needed to provide the requirement of 384.06 m^3.

$$\frac{130 \text{ gallons}}{\text{min.}} \times \frac{60 \text{ min.}}{\text{hr.}} \times \frac{1\ m^3}{264.2 \text{ gallons}} = 29.523\ m^3/\text{hr.}$$

is the capability of the system expressed on the m^3/hr. basis. Such that the no. of hours needed to provide 384.06 m^3 is:

$$\frac{384.06}{29.523} = 13.00 \text{ hours.}$$

Appendix C (cont'd).

(4) Operation in the 20th day will be finished in 13 hours also.

(5) The total hours required in the land preparation period is:

18 days x 20 hrs./day = 360 hours

plus: 2 days x 13 hrs./day = 26 hours

Total 386 hours

(b) During the cropping season period the crop at 9.13 mm/day irrigation level require 100 days of irrigation period. Hence, at 20 hours a day operation the system will operate at a total of 100 x 20 - 2000 hours during this period.

(c) The total operating hours for the whole production period is equal to the sum of the requirements for land preparation and cropping season periods as:

386 + 2000 = 2,386 hours

APPENDIX TABLE 1. Average charged expenses in well drilling, 1969.[a]

Operation	Sizes of wells ("Ø)						
	16"	14"	12"	10"	8"	6"	4"
(1) Moving Equipment in and out of site[b]	₱500 - ₱1,200.00 within Luzon						
	(Per foot cost)						
(2) Drilling & installing casing including costs of materials	₱61.25	₱53.95	₱47.72	₱40.60	₱31.90	₱23.50	₱16.75
(3) Perforation of casing with 1/8" slots	13.00	11.75	9.66	8.33	7.16	5.66	4.66
(4) Air developing well (12-24 hrs.)	₱ 41.25 per hour for all sizes						
(5) Pump testing (12-24 hrs.)	₱ 51.25 per hour for all sizes						
(6) Surface grouting (usually 20')	₱10.25 per foot average for all sizes						
(7) Contractor's tax	Constant at 3% of all above costs						
Average cost of casings	32.00	29.00	22.83	20.50	14.66	9.33	5.00

[a] Sources of data: J.V. Hoover & Co. Inc.; Shamrock Well Drilling Enterprises, Inc.; Wells and pumps, Inc.; Lopez, Emiliano Well Driller; I.C. de Guzman Well Drilling Enterprise and R. Reyes Big Pipes.

[b] ₱500.00 is charged for provinces adjacent to Manila and Suburbs. ₱1,200.00 is an average maximum as distance of site from Manila and Suburbs increased.

APPENDIX TABLE 2. Average cost of construction of a shallow tubewell model for 4" and 5" 0 centrifugal pump systems, 1969.[a]

SITE: Central Luzon with particular reference to N. E. province.

Item	Cost 4" 0	 5" 0
(1) Casing, B.I. schedule 40 pipes[b] length - 60'	₱ 300.00	₱444.00
(2) Drilling & installing casing,[c] depth - 100'	1,000.00	1,500.00
(3) Perforating casing,[d] length - 45'	209.70	234.00
(4) Sub-total cost	1,509.70	2,178.00
(5) Contractor's tax[e]	45.29	65.34
(6) Total cost	1,554.99	2,243.34

[a] Source of data: Local well drillers; ISU records; interview notes of the author; J. V. Hoover & Co. Inc.; Shamrock Well Drilling Enterprises, Inc.; Wells and Pumps Inc.; Lopez, Emiliano Well Driller; I. C. de Guzman Well Drilling Enterprise and R. Reyes Big Pipes.

[b] Computed at P5.00/ft for 4" 0 and P7.40/ft for 5" 0.

[c] Cost quoted by local well drillers. Computed at ₱10.00/ft for 4" 0 and P15.00/ft for 5" 0.

[d] Used quoted price from deepwell drilling companies in Manila and Suburbs. Costs are computed at P4.66/ft for 4" 0 and ₱5.20/ft for 5" 0.

[e] 3% of sub-total cost of construction.

APPENDIX TABLE 3. Average cost of construction of a telescopic deep well model for a 10" Ø discharge turbine pump system, 1969.[a]

SITE: Central Luzon with particular reference to N. E. province.

Item	Cost
(1) Moving equipment in and out of site[b]	₱ 600.00
(2) Drilling & installing the casing including cost of materials	
a) 14" Ø well, depth = 300' at ₱53.93 per foot	16,185.00
b) 12" Ø well, depth = 250' at ₱47.72 per foot	11,930.00
(3) Perforating casing with 1/8" slots[c]	
a) 14" Ø casing, length = 200' at ₱11.75 per foot	2,350.00
b) 12" Ø casing, length = 210' at P9.66 per foot	2,028.60
(4) Air developing well at ₱41.25/hr for 24 hrs.	990.00
(5) Pump testing well at ₱51.25/hr for 24 hrs.	1,230.00
(6) Surface grouting (20') at ₱10.25/ft	205.00
(7) Sub-total cost	35,518.60
(8) Contractor's tax (3% of (7))	1,065.56
(9) Total cost	₱36,584.16

a/ Source of data: Author's interview notes (1968 & 1969), J. V. Hoover & Co., Inc.; Shamrock Well Drilling Enterprises, Inc.; Wells and Pumps, Inc.; Lopez Emiliano Well Driller; I. C. de Guzman Well Drilling Enterprise and records of dug deepwells in Central Luzon.

b/ Average from five quotations is: ₱500 for provinces adjacent to Manila & Suburbs and P1200 for provinces farthest.

c/ Usually starts at about 100' below ground level. Most of the records inspected revealed that about 75% of total length of casing installed is perforated.

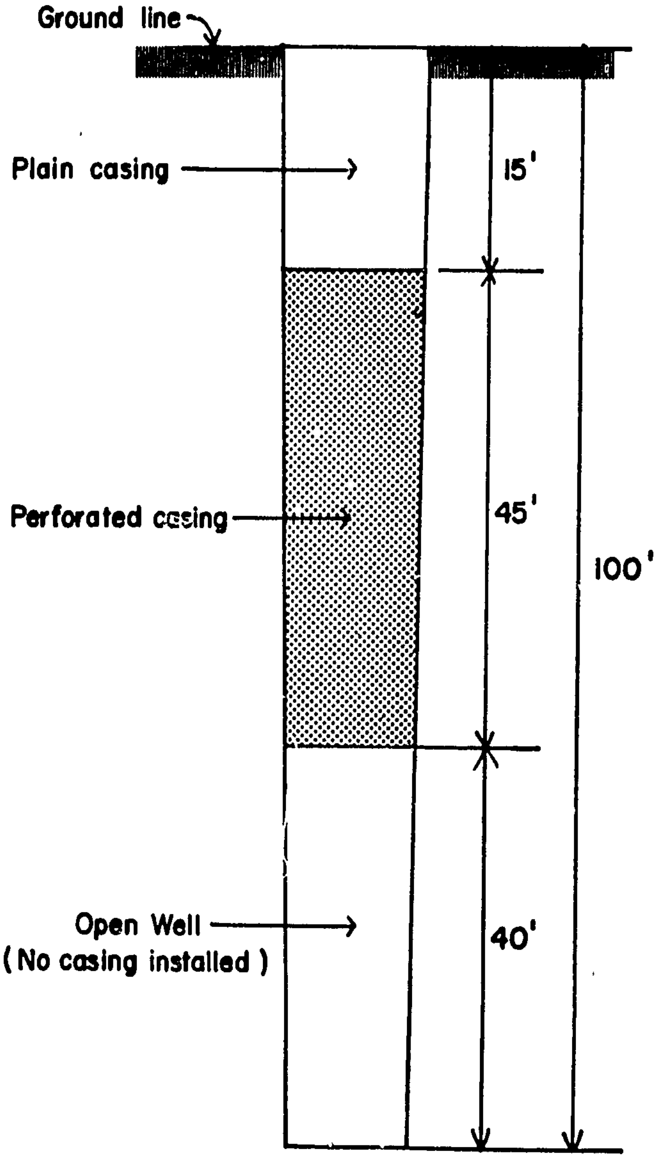
APPENDIX TABLE 4. Pump operating hours at farm project models irrigated by different type of systems and operated at various maximum daily duration during the cropping season.

Project set/ irrigation input	Types of pump systems								
	4" Ø S.T.W. centrifugal			5" Ø S.T.W. centrifugal			10" Ø D.W. turbine		
	L. P. a/	C.S. b/	Total	L. P. a/	C.S. b/	Total	L. P. a/	C.S. b/	Total
(mm/day)		(hours)			(hours)			(hours)	
		(10 hrs.)			(10 hrs.)			(10 hrs.)	
I/5	319.5	1150	1469.5	275.5	1150	1425.5	393.7	1150	1543.7
6	242.0	1100	1342.0	223.1	1100	1323.1	305.3	1100	1405.3
7	200.0	1050	1250.0	183.0	1050	1233.0	237.0	1050	1287.0
8	179.2	1000	1179.2	151.6	1000	1151.6	198.2	1000	1198.2
9.13	148.5	1000	1148.5	135.4	1000	1135.4	177.8	1000	1177.8
		(14 hrs.)			(14 hrs.)			(14 hrs.)	
II/5	400	1328	1728	400.0	1482	1882.0	480.0	1414.5	1894.5
6	400	1525	1925	351.0	1540	1891.0	464.0	1540.0	2004.0
7	320	1470	1790	275.5	1470	1745.5	358.4	1470.0	1828.4
8	271	1400	1671	232.0	1400	1632.0	310.0	1400.0	1710.0
9.13	228	1400	1628	194.0	1400	1594.0	260.5	1400.0	1660.5
		(18 hrs.)			(18 hrs.)			(18 hrs.)	
III/5	400	1328.0	1728.0	400.0	1482.0	1882.0	480.0	1414.5	1894.5
6	400	1525.0	1925.0	400.0	1701.7	2101.7	480.0	1622.5	2102.5
7	400	1697.8	2097.8	399.0	1890.0	2289.0	480.0	1806.0	2286.0
8	393	1800.0	2193.0	321.2	1800.0	2121.2	425.0	1800.0	2225.0
9.13	316	1800.0	2116.0	272.5	1800.0	2072.5	354.6	1800.0	2154.6
		(20 hrs.)			(20 hrs.)			(24 hrs.)	
IV/5	400	1328.0	1728.0	400.0	1482.0	1882.0	480	1414.5	1894.5
6	400	1525.0	1925.0	400.0	1701.7	2101.7	480	1622.5	2102.5
7	400	1697.8	2097.8	400.0	1895.0	2295.0	480	1806.0	2286.0
8	400	1848.0	2248.0	392.0	2000.0	2392.0	480	1966.0	2446.0
9.13	386	2000.0	2386.0	315.0	2000.0	2315.0	480	2244.0	2724.0

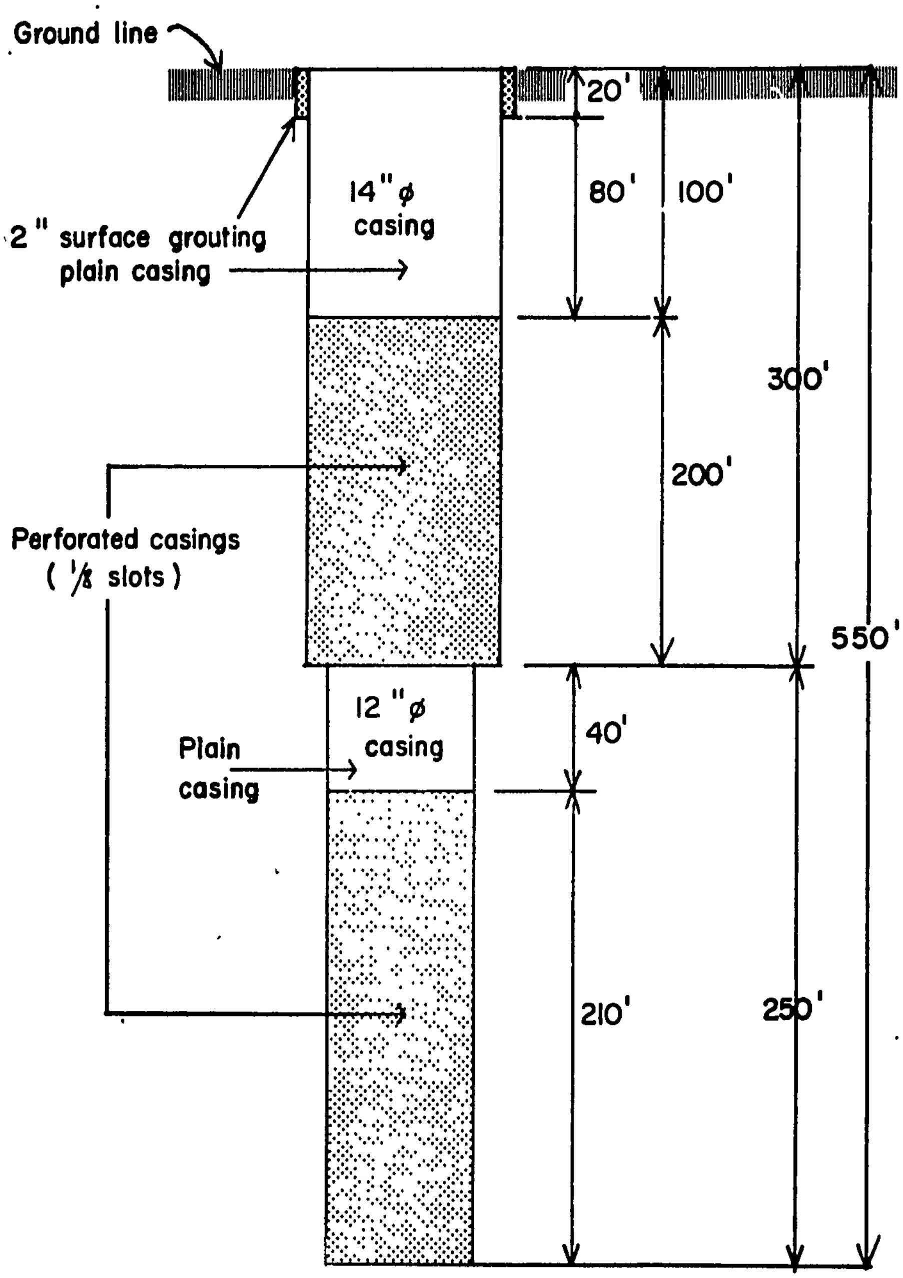
a/ Land preparation period. (The shallow tubewell centrifugal types were operated at 20 hours a day while the deepwell was operated at 24 hours a day during this period.)

b/ Cropping season period.

(hrs.) Specified maximum daily operating hours during the cropping season period.



Appendix Fig. 1. Schematic diagram of a shallow tubewell model for 4" ∅ and 5" ∅ centrifugal pump systems.
Site: Central Luzon, with particular reference to N.E. province.



Appendix Fig. 2. Schematic diagram of a telescopic deepwell model for a 10" ø turbine pump system.
Site: Central Luzon with particular reference to N.E. province.

THE AGLF CREDIT PROGRAM

Dominador A. Clemente, Jr.[1]

1.0 INTRODUCTION

The Agricultural Guarantee and Loan Fund (AGLF) was initiated in 1966 to support the Four-Year Rice and Corn Self-Sufficiency Program after encouraging results were obtained in pilot projects conducted in selected rural banks of Sta. Ignacia, Tarlac and Bay, Laguna.

The AGLF was initially capitalized at ₱7 million. Of this amount, ₱5 million was contributed by the NEC and the RCPCC. Another ₱2 million was provided by the RCPCC in 1967. On May 27, 1967, the sum of ₱10 million was provided by the SSS through the PNB. The GSIS also contributed ₱10 million on July 27, 1967 for a grand total of ₱34 million.

From fund sources, the money is channeled through the CB to participating rural banks in the form of Special Time Deposits earning an interest of 5 percent per annum. Rural banks grant production loans to farmers at 12 percent per annum with no collateral requirements. The loans mature in 6 months. Borrowers are not granted new loans unless the last loan has been repaid. In instances where matured loans cannot be collected, the AGLF assumes 70 percent and the rural bank 30 percent of the loss.

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[1] Instructor at the Mindanao Institute of Technology at Kabacan, Cotabato.

The amount of AGLF loans released by the CB to rural banks totalled ₱39,340,508.48 as of February 28, 1969 (Table 1). There were 1,534 loan releases to 193 participating rural banks in 37 provinces classified according to priority. Ten provinces composed Priority Area I while 27 provinces made up Priority Area II. Loans to Priority Area I amounted to ₱29,351,639.11 or 74.62 percent of the total loans granted.

Summarized according to region, the amount of ₱20.9 million or 53 percent of the total loans was released to 69 rural banks in Central Luzon with only ₱0.4 million released to 5 rural banks in Eastern Visayas (Table 2).

AGLF loans granted in this financing program consisted of short-term production loans, short-term commodity loans, medium-term and long-term loans. Short-term production loans aggregated around ₱23 million or 59 percent of the total amount loaned. Medium- and long-term loans totalling about ₱14 million were granted under the CB:IBRD Farm Mechanization and Development Program.

2,0 SAMPLING DESIGN

The survey sample involved 349 farmer-borrowers. This number of respondents was pre-set due to budgetary restraints and the time alloted for the study. The number of provinces selected in each region was determined on the basis of total amount loaned. Selection of provinces to represent the region was based on the number of rural banks in the province and length of time they have been operating under the AGLF program. Due to the inadequate number of rural banks participating in the AGLF program, Eastern and Western

TABLE 1. Summary of AGLF loan releases by province as of February 28, 1969.

Province	Number of Rural Banks	Number of Releases	Amount	Percent
Priority I				
Bulacan	13	148	₱ 2,991,551.89	7.60
Camarines Sur	4	26	1,060,956.62	2.70
Cotabato	5	64	2,134,530.13	5.43
Iloilo	10	78	1,825,774.08	4.64
Isabela	6	54	1,231,563.95	3.13
Laguna	14	126	2,780,684.65	7.07
Nueva Ecija	16	226	7,347,176.40	18.67
Pampanga	16	136	4,099,814.53	10.43
Pangasinan	14	146	3,166,225.21	8.05
Tarlac	6	74	2,713,361.64	6.90
Sub-total	104	1,078	29,351,639.10	74.62
Priority II				
Aklan	2	21	500,902.04	1.27
Albay	8	38	998,070.08	2.54
Antique	1	2	60,000.00	0.15
Bataan	2	12	548,177.17	1.39
Batangas	12	53	535,705.87	1.36
Bukidnon	4	4	395,000.00	1.00
Camarines Norte	1	2	25,204.50	0.06
Capiz	1	1	45,242.50	0.11
Cavite	6	24	382,111.02	0.97
Cebu	2	2	56,000.00	0.14
Davao	4	30	1,508,297.54	3.83
Ilocos Norte	1	3	35,000.00	0.09
La Union	2	10	141,708.55	0.36
Lanao del Norte	4	22	289,652.95	0.74
Leyte	2	15	365,027.34	0.93
Misamis Occidental	2	14	158,599.93	0.43
Misamis Oriental	2	10	235,460.36	0.63
Negros Occidental	9	39	1,019,310.02	2.59
Negros Oriental	1	1	2,190.22	0.02

(continued)

Table 1 (continued)

Province	Number of Rural Banks	Number of Releases	Amount	Percent
Nueva Vizcaya	1	18	497,568.08	1.27
Oriental Mindoro	3	22	465,189.92	1.18
Quezon	8	58	727,742.51	1.85
Rizal	3	3	56,394.82	0.14
Sorsogon	3	24	445,097.51	1.13
Zambales	2	8	121,700.00	0.31
Zamboanga del Norte	1	6	163,953.75	0.42
Zamboanga de Sur	2	14	209,563.70	0.53
Sub-total	89	456	9,988,869.38	25.38
Grand total	193	1,534	₱39,340,508.48	100.00

Source of data: Central Bank of the Philippines.

TABLE 2. Amount of AGLF loans released by the Central Bank, by region, as of February 28, 1969.

Region	Number of Rural Banks	Number of releases	Amount	Percent
Northern Luzon	10	85	₱1,905,840.58	5
Central Luzon	69	750	20,988,006.84	53
Southern Luzon	46	286	4,947,827.79	13
Bicol	16	90	2,529,328.71	6
Eastern Visayas	5	18	423,217.56	1
Western Visayas	23	141	3,451,228.64	9
Northern Mindanao	13	56	1,242,666.99	3
Southern Mindanao	11	108	3,852,391.37	10
Total	193	1,534	₱39,340,508.48	100

Visayas were combined into one region. The same was true for Northern and Southern Mindanao. Regional classification followed that of the Central Bank's system.

The number of samples per province was allocated in proportion to the number of borrowers. From each province, two rural banks with the largest amounts loaned and the greatest number of borrowers were chosen. The number of farmer-borrowers per rural bank was allocated in proportion to the amount loaned by each of the two rural banks previously chosen.

Moreover, a sample of 84 non-borrowers was taken for comparison with assisted farmers. Selection of non-borrowers in each survey area was based on proximity of their farms to those of the borrowers. This method of selection was followed to ensure that farms of borrowers and non-borrowers would have comparable physical characteristics.

Interviews were started in September, 1968 and terminated in December, 1968. Personnel from the ACCI and the Central Bank helped in the survey. Analysis and discussions of the lending operation of the AGLF covered crop year 1967-68. The same period was also the basis for analyzing the information on non-borrowers.

3.0 LIMITATIONS OF THE STUDY

One limitation of the study was the interviewer. It would have been ideal for only one person to gather all the information. Due to the large size of respondents and area covered, it was necessary to increase the number of enumerators. Seven persons collected information at different places in cooperation with the fieldmen of the Central Bank. Some variation in the techniques of gathering data was unavoidable. To minimize this variation, the enumerators were briefed on the questionnaire before interviews were conducted.

Another limitation was the probability of biased information. This could be due to reluctance of the farmers to provide the exact information. Some bias would be expected from farmers who defaulted on repaying their loans and among farmers who were apprehensive that the information they gave might be used against them for tax purposes. It was therefore necessary to give the proper introduction and explanations to gain their confidence.

A third limitation was the time interval between the harvest and the time of interview. Since the majority of farmers seldom keep records of their farm operations, most of the answers given were recited from memory.

4.0 REPAYMENT OF LOANS

Borrowers were classified into two categories: 1) delinquent borrowers were those who did not make any payments and those who only partially paid their matured loans, and 2) fully paid borrowers were those who fully paid their matured loans. There were 147 delinquent borrowers and 202 fully paid borrowers. Percentage-wise, the distribution was 42 percent and 58 percent, respectively.

Approximately 72 percent of the borrowers depended on crop sales as the source of repayment and 9 percent on livestock sales. Borrowing from others, savings and salaries accounted for 18 percent. One percent sold valuable property to repay loans.

Several factors which may affect repayment were examined. Factors which differed significantly between repayment groups were tenure status, cash receipts, cash expenses, size of farm and financial condition. The size of the loan was not an important variable.

An attempt was made to classify delinquent borrowers to facilitate distinction between those who did not make any payments at all on their matured loans (not paid borrowers) and those who made partial payments on their matured loans (partially paid borrowers).

The data available suggested that not paid and partially paid borrowers may be different types of borrowers. For example, it was ascertained that the cash receipts of partially paid borrowers were lower than those of not paid borrowers. This is an indication of the willingness of partially paid borrowers to repay their loans in spite of low cash receipts. For lack of sufficient information, this line of investigation was not pursued further.

4.1 Tenure

Table 3 shows the distribution of tenure groups based on repayment performance. Although share tenants had the lowest cash receipts, their repayment was comparable to that of owners whose percentage repayment was 62 percent. The total cash receipts of fully paid share tenants was computed to be ₱3,233, with cash expenses amounting to ₱2,685. The

TABLE 3. Distribution of tenure groups according to repayment performance, 349 AGLF borrowers, 1967-1968.

Tenure	Percent repayment of matured loans	Repayment status		Total
		Delinquent	Fully Paid	
Owner	62	29	48	77
Part-owner	54	20	24	44
Lessee	45	38	31	69
Share tenant	62	60	99	159
Total	58	147	202	349

residual amount of ₱548 was sufficient to enable them to repay their AGLF loans averaging ₱427.

4.2 Cash receipts

Only cash items and their equivalents were included in the determination of total income, since a large proportion of the expenses incurred were in the form of cash. There was a direct correlation of total receipts ranging from zero to ₱1,500 to repayment performance (Table 4). The hypothesis of independence between total receipts and repayment performance was rejected at the 30 percent level of significance, using the chi square statistic. However, the improvement in repayment was not consistent at higher ranges. This may be due to the fact that farmers at higher incomes tend to maintain a higher standard of living. As a guideline in extending loans, applications from farmers whose total receipts are below ₱1,500 should be scrutinized.

Fully paid borrowers had cash receipts of ₱5,922 compared to delinquent borrowers with ₱4,100 (Table 5). The difference in total receipts between repayment groups was statistically significant at the 20 percent level. Receipt items of significant difference between repayment groups were crop sales (20 percent level) and value of crops paid to creditors (10 percent level).

4.3 Cash expenses

Fully paid borrowers had cash expenses of ₱4,521 compared to delinquent borrowers with ₱3,487 (Table 6). The difference in cash expenses

TABLE 4. Relation of cash receipts to repayment, 349 AGLF borrowers, 1967-1968.

Amount	Percent repayment of matured loans	Repayment status		Total
		Delinquent	Fully paid	
Pesos				
0 - 500	38	21	13	34
500 - 1,000	56	14	18	32
1,000 - 1,500	56	20	24	44
1,500 - 2,000	61	13	20	33
2,000 - 2,500	68	6	12	18
2,500 - 3,000	55	13	16	29
3,000 - 3,500	77	5	14	19
3,500 - 4,000	62	5	8	13
4,000 & above	60	50	77	127
Total	58	147	202	349

TABLE 5. Summary of cash receipts according to repayment performance, 349 AGLF borrowers, 1967-1968.

Item	Repayment status		All farmers
	Delinquent	Fully paid	
		pesos	
Crop sales	1,865	3,301	2,696
Value of crops paid to creditors	182	449	336
Livestock sales	112	197	161
Other income of operator	973	872	914
Other income of members of family	968	1,103	1,046
Total	4,100	5,922	5,153

TABLE 6. Summary of cash expenses according to repayment performance, 349 AGLF borrowers, 1967-1968.

Item	Repayment status		All
	Delinquent	Fully paid	farmers
		pesos	
Living expenses	2,063	2,364	2,237
Farm operating expenses	606	1,121	904
Investments in farm assets	540	672	616
Unusual expenses	235	280	261
Value of interest payments	43	84	67
Total	3,487	4,521	4,085

between repayment groups was significant at the 20 percent level. The higher cash expenses of fully paid borrowers were due to larger cash receipts.

In general, the farmers studied had a higher standard of living than subsistence farmers. Living expenses were the major item of expenditure, averaging ₱2,237 for all borrowers. With an average size of 8 per family, the average per capita expenditure amounted to about ₱280.

4.4 Size of farm

Borrowers having 6 or more hectares had the highest rate of repayment. It should be noted that the amount of AGLF loans granted to farmers did not correspond to the total area being cultivated, but only to a portion of that area. This practice of the rural banks of limiting the size of loan was followed to minimize the risk of non-repayment. Although AGLF loans may not be available to finance operating expenses for 6 or more hectares, the additional yield from the area not covered by AGLF loans will be a source of income to repay loans. (Table 7)

4.5 Size of loan

The variation in repayment based on the average size of AGLF loans was statistically insignificant (Table 8). However, the low repayment in AGLF loans below ₱200 indicates that it is difficult to collect from farmers granted loans in this range, a difficulty which is compounded by administrative expenses. The rural banks may adopt a policy of not granting loans below ₱200.

TABLE 7. Relation of farm size to repayment, 349 AGLF borrowers, 1967-1968.

Size of farm	Percent repayment of matured loans	Repayment status		Total
		Delinquent	Fully paid	
Hectares				
2 and below	58	30	41	71
2 to 4	56	69	89	158
4 to 6	51	26	27	53
6 and above	67	22	45	67
Total	58	147	202	349

TABLE 8. Relation of size of AGLF loans to repayment, 349 AGLF borrowers, 1967-1968.

Amount	Percent repayment of matured loans	Repayment status		Total
		Delinquent	Fully paid	
Pesos				
200 and below	46	13	11	24
200 to 400	66	34	52	86
400 to 600	62	28	46	74
600 to 800	60	19	28	47
800 to 1,000	53	22	25	47
1,000 and above	56	31	40	71
Total	58	147	202	349

4.6 Financial condition

Of the total farm assets, the composition of current assets, working assets and fixed assets were comparable for both repayment groups (Table 9). The percentages were 3 percent, 15 percent and 82 percent, respectively. The high percentage of fixed assets indicates that most farm investments of both groups was in assets lacking liquidity.

Delinquent borrowers had total assets averaging ₱13,211. Fully paid borrowers' assets were ₱17,223. The variation in total assets between repayment groups was statistically significant at the 20 percent level. Delinquent borrowers had current liabilities of ₱858 incurred during the year 1967-68. Of this amount, ₱568 was the outstanding liability of AGLF loans.

5.0 ADMINISTRATION OF LOANS

The success of the AGLF program is not only dependent on social and economic factors, but also on individuals who process and supervise the loans. Included in this section is information taken from CB and RCPCC technicians and rural bank managers.

5.1 Loan maturity and repayment schedule

The repayment schedule, based on a 6-month maturity period, was considered too short by 58 percent of the borrowers. Proposals on length of maturity ranged from 7 months to more than 1 year with 26 percent suggesting maturity of loans at 11 months or less; 30 percent, 1 year; and 44 percent more than a year but not more than 2 years. Two major reasons given for extending the maturity period were marketing problems and crop failure.

TABLE 9. **Financial condition according to repayment performance, 349 AGLF borrowers, as of June 30, 1968.**

Item	Repayment status Delinquent	 Fully paid	All farmers
ASSETS:		pesos	
Current Assets:			
Cash	76	132	108
Crops stored	277	296	288
Supplies	31	32	31
Total Current Assets	384	460	427
Working Assets:			
Tools and equipment	1,274	1,332	1,308
Livestock and poultry	710	1,369	1,091
Total Working Assets	1,984	2,701	2,399
Fixed Assets:			
Land	8,224	9,978	9,239
Buildings[a]	1,807	3,258	2,647
Other fixed assets[b]	812	826	820
Total Fixed Assets	10,843	14,062	12,706
Total Assets	13,211	17,223	15,532
LIABILITIES:			
Current liabilities:			
Short-term loans this year	858	306	538
Short-term loans previous year	95	32	59
Total Current Liabilities	953	338	597
Fixed Liabilities:			
Real estate mortgage	751	838	802
Total Liabilities	1,704	1,176	1,399
Net Worth	11,507	16,047	14,133
Total Net Worth and Liabilities	13,211	17,223	15,532

[a] Includes dwellings, barns, and sheds.

[b] Includes household equipment, jeeps, automobiles, etc.

Among borrowers who had fully or partially paid, 53 percent paid after the maturity date. Reminders for loan payment were letters and personal contact; however, 17 percent of the borrowers were not reminded of their loans.

Of the 202 fully paid borrowers, 63 percent reported that the repayment schedule coincided with the marketing of their products. Among those whose marketing of products did not coincide with the repayment schedule, 84 percent claimed that the repayment date was early and 16 percent said it was late.

5.2. Loan approval

More than one-half (59 percent) of the loans released were approved within one week, 23 percent and 12 percent in 2 and 3 weeks, respectively. Approval for 6 percent came more than a month after the applications were filed with the rural bank. Reasons for the delay in approving loans were lack of funds and delay in the processing of papers, due to the absence of the rural bank manager or CB technician who was assigned to several rural banks.

The length of loan approval affected the timeliness of loan releases in relation to urgency of need with 48 percent of the farmers reporting loans released in advance, 22 percent on time and 30 percent, late. Of the total loans, 70 percent were released in installments. The remainder were released in lump sums which was a violation of a policy to schedule installment releases as the need arises. Installment releases are a means of minimizing the use of AGLF loans for consumption purposes or misapplication.

5.3 Size of loan

Farmers used previous production figures and expected yield as bases for determining the size of their loans. More than half of the borrowers, or 55 percent, were given loans smaller than their actual needs. Borrowers who got adequate amounts composed 27 percent, and 18 percent got loans bigger than their farming needs. Amounts in excess of actual farming needs were used for education, consumption, or to pay debts.

5.4 Farm plan

A requirement in obtaining loans was the farm plan. This was intended to help the farmer decide the best production methods. Unfortunately, the farm plan was not considered by all farmers as an aid to their farm operations but rather as a requirement to obtain loans. This fact was verified by 11 percent of the farmers who had not seen a farm plan. Among the farmers who had access to the farm plan, 77 percent found it useful. The remainder claimed they did not understand the farm plan or found it impractical.

5.5 Technical assistance

Supervision over farmer-borrowers was carried out by CB and RCPCC technicians. Borrowers, RCPCC technicians and rural bank managers found the overall performance of CB technicians satisfactory, but several complaints were registered against RCPCC technicians by rural bank managers, CB technicians and borrowers. These complaints concerned inability to make a farm plan, inadequate knowledge of farming and inefficient supervision of loans.

Technical advice given to farmers included the use of improved varieties, better land preparation, proper application of fertilizer and chemicals, pest and disease control and making of farm plans. Farmers have also availed themselves of services given by the private sector.

5.6 Attitudes toward the rural bank and the AGLF

Most of the borrowers, or 93 percent, expressed their desire to obtain another AGLF loan from the rural bank. The 7 percent who were not satisfied with the service given by the rural bank gave as reasons delayed approval of loan and too much paper work.

Rural bankers showed different reactions to the AGLF program. About one-half of the rural bankers were interested in continuing the program. However, some were reluctant to implement the program due to lack of security.

5.7 Benefits derived from loan and technical assistance

The greatest benefit was the availability of liberal credit, coupled with the education value of having introduced some improved methods of cultivation. This has resulted in meeting input requirements of new varieties to some extent. Usury was minimized.

Borrowers reported a mean yield of 37 cavans per hectare for crop years 1964-67, or before the AGLF was introduced. For crop year 1967-68, their mean yield was 53 cavans per hectare. Non-borrowers had a mean yield of 29 cavans per hectare for crop years 1964-67, and 49 cavans per hectare for crop year 1967-68.

For all borrowers, the average yield differential was 16 cavans as against 20 cavans for non-borrowers. Although non-borrowers had a higher yield differential, their mean yields before and after the AGLF were still lower than those of borrowers of the AGLF. The increase in productivity of non-borrowers was due to a varietal change. The fact that they had lower productivity levels may be due to a shortage of inputs for these new varieties. The farm operating expenses of non-borrowers were relatively lower than those of borrowers.

It is interesting to note that even before the AGLF was introduced, borrowers reported a higher productivity level than non-borrowers. This is not merely a coincidence. Two of the bases used for securing loans were past and expected yields, so that farmers who applied for and received loans were those whose yields were relatively higher. Borrowers attributed their higher yields to the use of new varieties, better farm management practices and more operating capital made available by AGLF loans.

Farmers cited the bigger risk involved in case of crop failure as the main disadvantage in the use of AGLF loans. Erratic price levels were another consideration. In most cases, RCA cannot purchase palay at the support price due to limited funds. Farmers had no recourse but to sell at lower prices.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The granting of liberal credit by the AGLF provided service to a large number of farmers who could not offer sufficient collateral. These farmers were able to purchase essential production inputs. The absence of security requirements, however, made the granting of production loans risky, especially in the case of farmers dependent on production as the main source of repayment funds. The repayment problem was magnified by lax collection efforts. Failure to collect from delinquent borrowers will serve as an encouragement for other farmers not to repay their loans.

To continue the program, a high rate of repayment must be attained. This can be done by efficient administration of loans and vigorous collection efforts. In some instances, collateral should be required. Strict selection of borrowers is important; farmers with the capacity and willingness to pay should be given credit. Capacity to pay can be measured by expected total cash receipts, while willingness to pay can be gauged from the past repayment performance on AGLF loans or loans obtained from other sources.

Since repayment is largely dependent on production increases, supervision in connection with improved farm practices is needed. RCPCC technicians must undergo training in farming skills. An alternative would be to replace RCPCC technicians with rural bank technicians in the supervision of farmers. This would, of course, entail additional operating expenses which can be subsidized by the government.

Farmers with increased production must be assured of a good market. AGLF borrowers could channel their products through the FaCoMa's. The services of the RCA may also be tapped; in the buying operation of the RCA, AGLF borrowers should be given priority over other farmers.

In case of crop failure, borrowers should be granted a reloan. The low income resulting from crop failure makes it difficult for the farmer to have funds for the next cropping season. Farmers who have paid their loans should be given priority since they have demonstrated their willingness to pay.

THE CB:IBRD CREDIT PROGRAM

Eugenio P. Ladrido[1]

1.0 INTRODUCTION

Credit plays a significant role in increasing farm productivity. Although the volume of new farm capital financed with credit has been small compared to that financed by the farmers themselves, such capital has often been substantial in amount and of high importance. The amount of new capital that can be financed by borrowing is related to income. The willingness and ability of local lenders to provide capital is affected to a large extent by the amount and trend of farm income, though it is also influenced by the amount of local bank deposits and the financial condition of the creditor and lender.

The small farmers that compose the bulk of the farm population have not played a significant role in Philippine agricultural development because their productive capacities have been curtailed by debts which, in most cases, are held over from previous generations and perhaps carried over into the next. The onerous nature of the credit conditions, which keeps the debt running for long periods and beyond redemption, constitutes the danger of rural indebtedness. Wallowing in debts, the small farmer realizes that he has lost control of his land and the price and free disposal of his crops. The burden of his debt has gnawed at the meager income of the farmer, keeping agricultural progress and prosperity and ultimately the social and economic development of the country from moving forward.

The inadequacy of agricultural credit stems from the way the banking systems in the country developed. Agricultural development was left almost entirely unaided by any long-range program with respect to the proper exploitation and financing of agricultural production. The commercial banking system flourishes in the country today, but is primarily concentrated within Manila and suburbs. Commercial banks have been found inadequate to meet the credit needs of a typical Filipino farmer.

To accelerate agricultural development, the government initiated various measures and projects aimed at providing incentives to farmers. Among these incentives was the expansion of credit facilities for production through rural banks. Thus, rural banks, while established along commercial banking lines, have for their primary purpose the servicing of farmers and agricultural enterprises which could hardly meet the requirements of a commercial bank. Their secondary purpose, which is no less important than the first, is to train rural folk in the use of banking facilities.

1/ Graduate Fellow, U. P. Cornell Program.

Until 1965 or for the past 12 years of its operation, the rural banking system has attended mainly to the short-term credit needs of eligible farmers and commercial and industrial borrowers. However, because this type of credit was more often used for recurring operational expenses, the overall objectives of the rural banking program of promoting and expanding the rural economy could not be vigorously pursued.

Farm borrowers have never enjoyed the experience of having surplus funds to invest in productive assets, hence they have no adequate means to accelerate their efforts for increased production. Compounding their problems is the fact that existing financial institutions specializing in granting medium- and long-term loans are generally reluctant to accommodate small farmers.

Medium- and long-term financing through the rural banks was initiated in 1966 with emphasis on farm mechanization. This study was conducted to obtain first-hand information on the lending operation and repayment of the medium- and long-term CB:IBRD (Central Bank:International Banks for Reconstruction and Development) loans to pave the way for a more efficient implementation of an additional $12.5 million.

It is hoped that the findings in this study can serve as a guideline for efficient lending procedures and plug loopholes in the present CB:IBRD loan scheme.

2.0 OBJECTIVES

This study was conducted with the following objectives:

(1) To appraise the operation of the CB:IBRD loan agreement and recommend remedial measures should problems exist;

(2) To determine the factors that influence the payment or non-payment of amortizations of the borrowers.

At the initial period of implementation of the CB:IBRD lending operations, 130 rural banks were authorized to participate under this program, 70 of which had implemented medium- and long-term loans aggregating ₱3.0 million.

The activities for the initial period centered mainly on laying the groundwork to insure the smooth implementation of the program. The early part of 1966 was devoted to a series of seminars and workshops, such as the Farm Mechanization Seminar, Observation and Appraisal of Dealers Workshop, Pre-Implementation Seminar, and the Promotional Campaign.

To assure further the effective implementation of the program, the active participation of other government agencies involved in agriculture was sought. Specifically, these agencies were the Agricultural Productivity Commission, the Bureau of Soils, the Bureau of Plant Industry, the Irrigation Service Unit of the Department of Public Works and Communications, and the Philippine Fisheries Commission. In this connection, the Governor of the Central Bank of the Philippines and the various heads of the agencies mentioned, excecuted a memorandum of understanding on Technical Cooperation. Under the memorandum which was undertaken on February 11, 1966, the technicians of these agencies would assist in the implementation of this financing program.

After three years of operation, the unwithdrawn or unavailed of portion of the $5 million credit line with the IBRD was only $163.82[2/] or ₱640.54 at an exchange rate of ₱3.91 to the dollar. A total of $4,999,856.18 was already withdrawn and released to farmers in the form of special time deposits.

Taking advantage of these loans were 2,510 farmers who were extended loans through 143 rural banks for the: (1) acquisition of farm tractors and accessories, and (2) development of small irrigation systems, fish culture and livestock and poultry projects.[3/]

3.0 THE CB:IBRD PROGRAM

In this study there were 18 rural banks visited in nine provinces of the country. The total amount of loans granted to the 179 borrowers sampled from the 18 rural banks was ₱2,099,929. Table 1 shows the rural banks that were visited, the number of borrowers sampled per rural banks, and the amount of loans granted to all the sample borrowers in each rural bank together with the total for the province.

3.1 Administration

The burden of administration of the lending operation of the CB:IBRD Program fell heavily on the rural bank and the CB farm technician. Administration deals primarily with the screening of eligible borrowers and appraisal of requirements necessary for the loan application. In addition, the CB technician prepares a project study and, together with the borrower, makes a farm and home plan, determines the applicant's capacity to pay and prepares a repayment schedule.

[2/] Monthly Report as of February 29, 1969 to the Monetary Board Department of Rural Banks, CB.

[3/] Ibid.

TABLE 1. Area, number of borrowers, rural banks and amount of loans granted.

Province	Rural Banks	Number of borrowers	Amount	Total
Isabela	San Mateo	11	₱132,315	₱ 284,835
	Santiago	9	152,519	
Tarlac	Sta. Ignacia	11	57,462	96,607
	La Paz	7	39,145	
N. Ecija	Sta. Rosa	16	314,161	609,666
	Talavera	10	295,505	
Bulacan	Guiguinto	13	113,214	226,801
	Marilao	9	113,587	
Laguna	Biñan	5	29,666	234,508
	Lilio	11	204,842	
Quezon	Sariaya	18	101,321	136,062
	Candelaria	10	34,741	
Albay	Oas	7	40,147	113,109
	Rinconada	9	72,962	
Iloilo	Pototan	13	94,372	224,214
	Passi	9	129,841	
Cotabato	Cotabato	6	120,013	174,127
	Midsayap	5	54,114	
Total		179		₱ 2,099,929

3.2 Eligibility of borrowers

Borrowers eligible under the program were the following:

(a) Farmers owning or cultivating not more than fifty (50) hectares of arable land dedicated to agricultural production;

(b) A duly organized farmer's cooperative;

(c) An individual rendering direct agricultural production services with capital investment of not more than twenty-five thousand pesos (₱25,000).

Only development projects in viable farm units where the potential for increased production is clearly established were to be eligible for loans. Particularly with regard to farm machinery and except for special circumstances, the proceeds of the bank loan were applied according to the following conditions, except where the farmers undertake outside custom work:

(1) Under single cropping conditions, wheel tractors were financed only when the farm area was 40 hectares or more, and under double cropping conditions, the area was reduced to about 25 hectares.

(2) Under single cropping, hand tractors were financed for farms of 8 hectares or more, and under double cropping, the farm area was reduced to 5 hectares.

3.3 Amount of loan

The amount of loans granted depended on the cost of the object of financing, needs of each borrower, collateral being offered, and borrower's creditworthiness. Loans granted did not exceed 70 percent of the appraised value of immovable property offered as security, and this security must be in a first mortgage. The amount of any loan by a rural bank to an end-user was, in the case of a chattel mortgage or plědge, not more than 50 percent of the appraised value of the object financed or, where such object purchased was new, 50 percent of the bill of sale. Where additional security to the object financed was given, the amount of the loan was increased to the full cost of the object financed. The rural banks in all cases provided not less than 10 percent of the cost of the object.

3.4 Security for the loan

The security consisted of a first mortgage on immovable property and/or chattel mortgage property. Government agencies' instrumentalities fully backed up by the Central Bank and guaranteed by the Republic of the Philippines were also accepted at face value. The yearly real estate tax receipts and insurance premiums were required to be presented as these documents fell due.

Among the 179 loans studied, 83 were secured by a real estate mortgage and the rest by chattel mortgages of machinery and other movable property. All these loan securities were inspected by the rural bank inspector.

3.5 Maturities of loans and the repayment schedule

The following maturity periods were set for the loans granted: (a) Farm implements were not to exceed 3 years and light machineries not more than 4 years; (b) Irrigation pumps and engines, piggery and poultry were not to exceed 5 years; (c) Heavy machineries were not to exceed 7 years; and (d) Loans not to exceed more than 10 years were loans intended for any complete development of irrigation system or fishpond.

The repayment schedule was drawn up by the farm technicians of the CB based on the Farm and Home Plan with the approval of the rural bank managers. In principle, the schedule was supposed to coincide with the marketing of the borrower's products. Only 67 percent of the borrowers agreed that this was the case, 33 percent did not.

Thirteen percent of the borrowers indicated that the date of the first amortization came too soon, the period was too short. From the point of view of the CB technicians, however, these borrowers were granted these loans because of their projected ability to pay the first amortization.

3.6 Interest rates

The interest rate charged annually by the IBRD on the CB was 5-1/2 percent and the CB in turn charged the rural banks 6-1/2 percent. The rural banks charged the borrowers 12 percent and this was not discounted in advance. Considering that these are development loans, 15 percent of the borrowers suggested that the interest rate be lowered so that more farmers could take advantage of these loans.

3.7 Loan processing

Loan processing is either done in the rural bank or both in the rural bank and Central Bank. Loans of ₱15,000 and below are processed in the rural bank. For loans above ₱15,000, the loan is processed in the rural bank and if the project is feasible, it is recommended for approval and forwarded to the Central Bank where the Loan Committee makes the final decision.

Borrowers complain of the trouble they have to take while their loan is being processed. Twenty-seven percent of the borrowers complain that the processing takes so long that the release of their loan is very much delayed. Seventeen percent complain about expenses during processing. A borrower has to spend for inspection fees, notarial fees, insurance and transportation going to and from the rural bank.

3.8 Technical assistance and supervision

In order that the Central Bank-IBRD loan program can be implemented wisely and in the right manner, technicians from different government agencies, assisted by the CB technicians and rural banks demonstrate to the farmers the right technique in the use of hand tractors, improved rice culture, improved management practices, pest control and other technology necessary for a good harvest and thus repayment of loan amortizations. One hundred fifteen borrowers of the 179 interviewed admitted that they had been assisted by these technicians, constituting 66 percent of the borrowers in the study. This includes only 20 percent of the borrowers who were serviced by the Central Bank technician.

3.9 Collection

The procedure of collection by the rural bank was not clearly defined but in general there was no need for an all-out campaign for collection of matured loans. The more usual procedure was for the rural bank to send out reminders either by mail or by contact.

Of the 179 borrowers, 154 loans had already matured and 17 became delinquent or past due loans. Of the 154 with matured loans, 130 were reminded of their loan obligations, or 85 percent of those borrowers with matured loans were contacted.

3.10 The CB:IBRD loan borrower

The typical CB:IBRD loan borrower was 48 years old. Ninety-five percent were married and the average size of the farm family was eight persons. Fifty-three percent of the borrowers were graduates from high school and more than half of this group has taken professional courses in college. The average farm area was 56 hectares and effective crop area planted to rice was 17 hectares.

3.11 Repayment of CB:IBRD loans

One hundred twenty-four borrowers were up to date in the payment of their loan amortizations and 13 borrowers had paid in full. The up-to-date borrowers were classified as regular borrowers and those borrowers who paid in full were classified as fully paid borrowers. Twenty-five loans have not fallen due and thus were classified as not due. As already mentioned, 17 borrowers failed to pay their amortization by the maturity date and these were classified as delinquents.

The financial condition of the farmers which reflects the farmers' ability to stand unexpected low income and unpredictable losses and expenses[4] showed that the delinquent borrowers had lower total assets and net worth than the repaid (regular and fully paid) borrowers. This low asset structure of the delinquent borrowers was characterized by a current asset composition which was not liquid (Table 2).

The financial tests in terms of the current and intermediate ratios[5] (Table 3) also reflected this non-liquidity and indicated that the delinquent borrowers could not adequately provide for the repayment of short- and medium-term loan obligations. This group of borrowers were also less efficient in terms of capital output ratio which measures how many pesos worth of capital is needed to produce a peso worth of product.

The regular borrowers had a higher total asset figure than the delinquent and the fully paid borrowers. This asset structure was composed of a very high current ratio and a normal intermediate ratio.[6] The regular borrowers are more efficient than both the delinquent and fully paid borrowers as indicated by the capital output ratio.

In terms of long run liquidity position of all repayment groups, the net capital ratios[7] reflect that there is a very strong likelihood that sale of all assets of the farm business would produce sufficient cash to cover all liabilities. This financial condition of the different repayment groups was confirmed by the

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[4] A. G. Nelson and W. G. Murray, Agricultural Finance, 5th Edition, Iowa State University Press, 1967, p. 189.

[5] Current Ratio: $\frac{\text{Current Assets}}{\text{Current Liabilities}}$; Intermediate: $\frac{\text{Current \& Inter. Assets}}{\text{Current \& Inter. Liab.}}$

[6] The rule of thumb for current and intermediate ratio is 2:1, that is, every peso of liability must be covered by ₱2 of assets. See R. N. Anthony, Management Accounting, Revised Edition, R. D. Irwin, Inc., Homewood, Illinois, 1960, Chapter 11.

[7] Net capital ratio: Total Assets/Total Liabilities.

TABLE 2. **Financial condition as of June 30, 1968 according to repayment 179 CB:BRD borrowers,1967-1968.**

ITEMS	CLASSIFICATION Delinquent	Regular	Fully paid	Not due	All farms
Assets					
Current	932	2,663	2,577	2,088	2,412
Working	1,799	3,056	1,084	2,593	2,728
Fixed	64,797	82,530	66,441	63,228	76,982
Total Assets	67,528	88,249	70,102	67,909	82,122
Liabilities:					
Current (previous)	365	346	823	460	398
Current (67-68)	113	113	154	382	154
Medium term	3,605	2,310	3,398	2,351	2,422
Long term	4,990	9,729	3,474	7,412	8,501
Total Liabilities	9,073	12,498	7,849	10,605	11,475
Net worth	58,455	75,751	62,253	57,304	70,647
Total Liabilities and Net Worth	67,528	88,249	70,102	67,909	82,122

TABLE 3. Balance sheet ratios and percentages according to repayment 179 CB:IBRD borrowers, 1967-68.

ITEMS	CLASSIFICATION Delinquent	Regular	Fully paid	Not due	All Farms
Current ratio	1.95	5.67	2.64	2.48	5.34
Intermediate ratio	0.67	2.06	1.06	1.47	1.79
Net capital ratio	8.38	7.08	9.05	6.40	7.15
Capital-output ratio	7.01	6.09	8.64	11.91	8.41
Average percent equity	88%	85%	88%	84%	86%

average percent equity figures which measure the ultimate solvency of the farm business. As a rule of thumb, 50 percent is considered ideal.[8] All repayment groups were in a relatively safe financial condition in terms of these figures with 88 percent, 85 percent and 88 percent for delinquent, regular and fully paid borrowers, respectively.

The delinquent borrowers had the lowest net disposal income relative to the repaid borrowers (Table 4). Net disposable income measures the capacity to pay back debts after farm operating and living expenses were deducted from total receipts. This situation among the delinquent borrowers was due to very low cash receipts (Table 5), especially in rice sales which was the main source of receipts for all CB;IBRD borrowers. Receipts coming from the operator's other income was also low. The delinquents also had high operating and living expenses (Table 6).

The fully paid borrowers had low cash receipts, low farm operating expenses and low living expenses. There was no statistically significant difference between the net disposable income of the delinquent and the fully paid borrowers.

The regular borrowers had the highest net disposable income among the repayment groups. This was characterized by high cash receipts, particularly in rice sales and the operator's otherincome (Table 5). This group of borrowers had relatively low farm operating and living expenses.

A further measure of efficiency in terms of income generation in farming is reflected by the gross and operating ratios (Table 7). The gross ratio is the over-all measure of the income producing ability of the farm operation.[9] It is also a measure of efficiency. The operating ratio on the other hand pertains only to operating expenses and these are related to gross income. These two ratios have the advantage of comparability from one farm to another and from year to year for the same farm.

In Table 7, the regular borrowers were the most efficient, followed by the fully paid borrowers with a gross ratio of 0.50 and 0.74, respectively. This meant that regular and fully paid borrowers spent P0.50 and P0.74 for every peso of gross revenue. The delinquent borrowers had a gross ratio of P0.83. In terms of the operating ratio, the same groups of borrowers were also the more efficient. Total operating expenses amount to P0.54 per peso of gross income for delinquent borrowers and only P0.31 and P0.34 for regular and fully paid borrowers.

8/ Nelson and Murray, op.cit., pp. 52-66.

9/ Gross ratio: Total Expenses/Gross Revenue.

TABLE 4. Total cash receipts, farm operating and living expenses and net disposal income 179 CB:IBRD borrowers, 1967-68.

ITEMS	CLASSIFICATION				All farms
	Delinquent	Regular	Fully paid	Not due	
Total cash receipts	13,858	22,144	10,691	11,176	18,994
Less:					
Farm operating expenses	5,175	4,804	2,789	3,065	4,377
Living expenses	5,257	4,484	3,627	3,700	4,212
	10,432	9,288	6,416	6,765	8,589
Net disposable income	3,426	12,856	4,275	4,411	10,405

TABLE 5. Summary of cash expenses according to repayment 179 CB:IBRD borrowers, 1967-68.

ITEMS	CLASSIFICATION Delinquent	Regular	Fully paid	Not due	All farms
Farm operating expenses	5,175	4,804	2,789	3,065	4,377
Living expenses	5,257	4,484	3,627	3,700	4,212
Investments in farm assets	396	691	762	852	939
Unusual expenses	450	472	546	166	532
Value of interest payments	358	586	204	852	939
Total cash expenses	11,636	11,037	7,928	8,635	10,999

TABLE 6. Summary of cash receipts according to repayment 179 CB:IBRD borrowers, 1967-68.

ITEMS	CLASSIFICATION				All farms
	Delinquent	Regular	Fully paid	Not due	
Rice sales	4,296	9,319	7,405	4,048	7,967
Other crop sales	4,522	3,937	307	361	3,229
Value of crop paid to creditors	439	967	66	1,255	892
Other income of operator	1,506	2,475	432	2,087	2,180
Other income of members of family	1,471	1,673	1,513	1,053	1,556
Livestock sales	365	265	326	37	247
Custom hire	1,259	3,508	640	2,335	2,922
Total cash	13,858	22,144	10,689	11,176	18,993

TABLE 7. Ratios related to receipts and expenses according to repayment 179 CB:IBRD borrowers, 1967-68.

ITEMS	CLASSIFICATION				All farms
	Delinquent	Regular	Fully paid	Not due	
Gross ratio	0.83	0.50	0.74	0.74	0.56
Operating ratio	0.54	0.31	0.34	0.54	0.35

There was no consistent pattern in repayment rate of the borrowers when repayment was related to size of loan. Further study and investigation is needed in this aspect of the CB;IBRD loans to determine a definite relationship between size of loan and repayment.

In general, there was no significant difference in the receipts and expense items among tenure groups. This was also reflected by the gross and operating ratios by tenure (Table 8). In descending order, part-owners and owners had the highest total assets followed by lessees and share tenants who had the lowest (Table 9). There was a highly significant difference between the total assets of owners and part-owners relative to the share tenant.

Based on a rule of thumb intermediate ratio of 2:1, only the owners and part-owners can adequately repay. As reflected in their financial condition, owners and part-owners had intermediate ratios of 2.07 and 2.35, respectively, while lessees and tenants had 1.04 and 1.19, respectively.

4.0 CONCLUSION

In terms of number of loans repaid, a repayment rate of 89 percent was achieved in CB:IBRD loans among the 154 loans that matured. This was indicated by a highly favorable financial condition of the repaid borrowers relative to the delinquent borrowers.

In this credit program in the future, farmers with a solid financial condition within the rules for eligibility should be granted this type of credit. These farmers must generally be owners and part-owners and lending to lessees and tenants must be on a case-to-case basis.

This requires a strict enforcement of the submission of a farm plan while the credit investigation should be rigidly followed, especially on the borrower's character and past credit performance as this could reflect his capacity and willingness to pay.

In the over-all view, the CB;IBRD program has been successful in that it was widely participated in, but a few kinks ought to be straightened. Being development loans, interest rates should seek the level of interest in development loans. Processing of loan documents should be hastened and CB personnel and personnel of the other government agencies should have a feeling of involvement in this economic development program.

Lastly, the farmer should also have this feeling of involvement and understand that each individual in the program - the rural banker, the farm technician, the machinery dealer, and he himself - has a role to play in the agricultural community. Failure to play one's role means the failure of the program.

TABLE 8. Ratios related to receipts and expenses according to tenure, 179 CB:IBRD borrowers, 1967-68.

ITEMS	CLASSIFICATION				All farms
	Owners	Part-owners	Lessees	Share tenants	
Gross ratio	0.56	0.55	0.57	0.57	0.56
Operating ratio	0.23	0.22	0.24	0.23	0.23

TABLE 9. Financial condition as of June 30, 1968, by tenure 179 CB:IBRD borrowers, 1967-68.

ITEMS	TENURE				All farms
	Owners	Part-owners	Lessees	Share tenants	
Assets:					
Current	2,657	2,478	2,047	1,644	2,412
Working	2,997	2,975	2,308	1,854	2,728
Fixed	84,967	87,424	66,432	44,933	76,982
Total Assets	90,621	92,697	70,787	48,431	82,122
Liabilities:					
Current (previous)	149	168	59	233	154
Current ('67-68)	372	120	641	559	398
Medium term	2,205	1,953	3,492	2,957	2,422
Long term	8,406	16,799	5,435	5,422	8,501
Total Liabilities	11,132	19,040	9,625	9,171	11,475
Net Worth Total	79,489	73,657	61,162	39,260	70,647
Liabilities and Net Worth	90,621	92,697	70,787	48,431	82,122

TABLE 10. Balance sheet ratios and percentages by tenure 179 CB/IBRD borrowers, 1967-68.

ITEMS	TENURE Owners	 Part-owners	 Lessees	 Share tenants	All farms
Current ratio	5.10	8.60	2.92	2.91	5.34
Intermediate ratio	2.07	2.35	1.04	1.19	1.79
Net capital ratio	8.14	4.87	7.35	5.27	7.15
Capital-output ratio	2.06	1.53	2.70	4.17	8.41
Average percent equity	87%	80%	86%	81%	86%

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A STUDY OF TRACTOR- AND CARABAO-CULTIVATED FARMS IN LAGUNA

Nelly G. Alviar[1]

1.0 INTRODUCTION

The success of mechanization in highly developed farming countries has led many governments to conclude that they could solve their food production problems by following similar lines. The rapid introduction of hand tractors and the equipment that goes with them into countries long dependent on animal power has been very expensive, but successful.[2]

Although mechanization of Philippine agriculture is sometimes offered as the answer to the problem of low labor productivity on farms, most farmers are still engaged in traditional or animal-powered type of farming. Attempts in recent years to partially replace work animals with tractors have not been very successful, partly because of the farmer's lack of capital and lack of training in the operation of these machines. However, capital at reasonable interest rates has been made available to many of the farmers to provide for purchases of machines.

This study has been concerned with the comparative analysis between tractor and carabao use in lowland rice farms. The purpose is not to prove that either tractor or carabao is superior but to understand more clearly the factors associated with its use. The hand tractor is used in Philippine rice culture principally as a substitute for the carabao in land preparation. Information is drawn from recent surveys to describe the: 1) trend in tractor adoption, 2) tractor purchasing and financing, 3) economic environment and physical resources on tractor and carabao using farms, and 4) economic efficiencies derived from tractor use. The primary purpose is to provide information and assistance to farmers who plan to mechanize farms or for governments who wish to encourage mechanization and through mechanization higher labor productivity.

The study has 5 years of data on 50 farms in Laguna. The first and the fourth year data have greater coverage with 150 farms each. Information has been compiled on cost and maintenance of tractors, farm area, production, disposal, capital investment and labor input. The first year data was analyzed here in more detail and was compared to carabao-cultivated farms data in the same province during the same year. Changes that occurred in the 50 farms within 5 years were noted.

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[1] Research Assistant, Department of Agricultural Economics, U.P. College of Agriculture. The author wishes to thank Dr. Randolph Barker, Agricultural Economists, IRRI, for his constructive comments.

[2] Cornelius Davies, "Consideration and Procedures for the Successful Introduction of Farm Mechanization," FAO Agricultural Development Paper 44, 1964.

2.0 TRACTOR ADOPTION

2.1 Reasons for tractor purchase

A majority or 60 percent of the 150 respondents indicated that their reason for tractor purchase was associated with the problems and nuisance value connected with carabao maintenance. A somewhat smaller number gave a direct economic reason - savings in time. The influence of psychological factors such as prestige associated with tractor ownership cannot be easily determined. However, the heavy concentration of tractors in some barrios as opposed to others does suggests that "keeping up with the neighbors" has had an important effect.

2.2 Trend in increase in tractor use

Studies of both the University of the Philippines, College of Agriculture (UPCA) and the International Rice Research Institute (IRRI) on hand tractors in Laguna showed an increasing trend in tractor use.

Among respondents in the three municipalities studied in Laguna, it was found out that only one tractor unit was introduced in 1959. There were four in 1960, and by 1961, the number had increased to six. From then on rapid increases occurred during the three succeeding years: 50 in 1962, 58 in 1963, and 68 in 1964. Follow-up studies were done on tractor-owners drawn from the original sample and during the 1965-66 crop year, each farmer now owned at least one tractor. When the 1966-67 crop year rolled around, 50 percent of al' the operators studied already owned two or more hand tractors.

2.3 Manner in which tractors are purchased and financed

Hand tractors are usually purchased in cash or on an installment basis from local agents. Of the farms surveyed, 82 tractors or 44 percent of the total tractor purchases were on a cash basis. While the majority of the tractors were purchased from distributing centers in Manila and their provincial and city branches, a few were bought directly from Japan. The purchase price varied widely between individual hand tractors, even among those purchased within the same year. Differences were primarily due to attachments like plow, harrow, iron wheel, rotavator, and trailers, etc., and also on the type of engine used, either diesel engine or gasoline engine.

2.4 Source of funds for tractor purchase

Farmers stated that funds for 98 percent of the total cash tractor purchases came from savings and crop sales. Sources of borrowed funds were banks, landlords, relatives and friends, and private money lenders (Table 1).

Ordinary bank loans requiring collateral have a 12 percent interest rate and mature in 4 years. Here, the most common are the Rural Bank loans well known as the CB:IBRD (Central Bank : International Bank for Reconstruction and Development) and the AGLF (Agricultural Guarantee and Loan Fund). There was no information gathered on how long term loans are being repaid. However, follow-up studies revealed that there were two cases where tractors were returned because the owners could not pay the required amount after the second year of purchase. The same study revealed that 50 percent of the newly purchased tractors were financed by funds borrowed from the rural banks through the CB:IBRD loans.

3.0 ECONOMIC ENVIRONMENT AND FARM RESOURCES

3.1 The area studied

Studies of farms using hand tractors in land preparation and of farms using carabaos were both done in the province of Laguna where more than 50 percent of the farmers were engaged in rice production. The carabao-cultivated farms studied were located in the northwestern part of Laguna which included the adjacent municipalities of San Pedro, Biñan, Sta. Rosa and Cabuyao. Areas considered for the hand tractor study were the municipalities of Calauan, Victoria and Pila where most of the land preparation on rice paddies is done with the use of hand tractors. Table 2 lists some of the farm characteristics by farm group and by year of study.

3.2 Size of farm

The average farm area of the tractor-operated farms was more than double that of the carabao-cultivated farms. Tractor-operated farms ranged from 0.7 to 25 hectares and the effective crop area ranged from 1.4 to 50 hectares as against an effective area of 0.4 to 13 hectares for the carabao-using farms. Similar findings were noted in the studies of De los Reyes, et. al., 3/ and

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3/ De los Reyes, B. N., et. al., "A Case Study of the Tractor- and Carabao-Cultivated Lowland Rice Farms in Laguna," The Philippine Agriculturist, Vol. 49, No. 2, 1965, pp. 75-94.

TABLE 1. Source of financing cash and installment tractor purchases, 187 hand tractors, Laguna, 1964-65.

ITEM	SOURCE									
	Saving	Crop sale	Carabao sale	Land sale	Land-lord	Bank[a/]	Relatives & friends	Private money lenders	Not specified	Total
CASH										
Source of cash:										
No. reporting	72	8	1	1						82
Percent of total	88	10	1	1						100
DOWN PAYMENT AND LOAN:										
Source of down payment:										
No. reporting	28	47	2							77
Percent of total	36	61	3							100
Source of loan:										
No. reporting					12	8	4	4		28
Percent of total					43	29	14	14		100
Source of repayment:										
No. reporting		19							9	28
Percent of total		68							32	100

[a/] Rural Bank.

TABLE 2. Farm characteristics by farm group and by year, Laguna, 1964-1969.

ITEM	Carabao	Tractor				
	1964-65	1964-65	1965-66	1966-67	1967-68[a]	1968-69
Number of farms	123	150	50	50	50	50
Number of hand tractors/or work carabaos	200	187	72	83	82	73
Land use intensity:						
Average size of farm (Ha.)	2.3	4.8	4.6	4.6	4.6	4.5
Area double cropped (Ha.)	1.4	4.8	4.5	4.7	4.6	4.2
Effective crop area (Ha.)	3.7	9.6	9.1	9.3	9.2	8.7
Percent double cropped (%)	62.2	100.0	97.8	97.9	100.0	93.3
Tenure:						
Tenant	119	121	35	36	36	35
Part-owner	2	20	14	12	12	12
Full-owner	2	9	1	2	2	3
Production:						
Yield per hectare (cav.)	52	58	62	70	73	69
Labor requirement: (Man days/ha.)						
Total man labor days	77	74	64	67	76	64
Plowing and harrowing only	20	13	12	12	11	10

[a] The original 50 farm cooperators were used in this table for comparison.

Gutierrez.[4] De los Reyes had 3.6 hectares as the average size of tractor-operated farms and 1.4 hectares for farms using carabao while Gutierrez had 8.9 and 3.0 hectares for tractor- and carabao-cultivated farms, respectively. Aguila's[5] study on the business management of tractor-operated farms had an average area of 4.7 hectares. There was not much change in the farm area of the tractor-operated farms during the 5-year period.

3.3 Irrigation facilities

In the municipality of San Pedro, artificial irrigation was not available during the dry season. In Biñan and Sta. Rosa, artificial irrigation was available but was insufficient. These are mostly pump-irrigated. Farms in different areas took turns in the use of water for the second planting. Due to lack of rivers and the breakdown of the irrigation system in Cabuyao, only those with privately owned pumps were able to plant 2 crops of palay during the year so that the area double-cropped was only 1.45 hectares.

While the problem in the northwestern part of Laguna was the scarcity of water, some farmers in Victoria and Pila were plagued by too much water, made even worse by poor drainage. Farmers tried improving their drainage and irrigation project to enable them to also plant during the dry season. With fairly good drainage and their ample supply of water, irrigation in the area now is good. Since farmers can now plant twice a year, 100 percent double-cropping is expected.

3.4 Tenure status

It can be observed from the same table that landholdings in the area studied are primarily in the hands of the landlords accounting for 81 percent of the tractor-operated farms and 97 percent of the carabao-cultivated farms. Two part-owners changed status during the third year of the study. One bought part of his tenanted farm and became a full owner while the other one sold part of the farm that he owned and became a tenant. Another tenant became a full owner during the last year.

3.5 Labor requirement

A total of 74 man-days per hectare was noted in the tractor-operated farms and 77 in the carabao-cultivated farms. In both farms, weeding and replanting showed the greatest labor requirement. The second largest amount of man-days was utilized in the harvesting and threshing of palay. There was heavy dependence of farm labor on hired hands accounting for 77 percent in the tractor-operated farms and 51 percent in the carabao-operated farms. Hired labor was employed for land preparation and harvesting. Transplanting is another operation requiring much labor and often done by hired female laborers.

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[4] Gutierrez, R. R., "Business Management of Lowland Rice Farms Using Hand Tractors in Northwestern Laguna, 1966-67," Undergraduate thesis, 1967.

[5] Aguila, B. H., "Business Management in Rice Farms Using Hand Tractors," Undergraduate thesis, 1966.

3.6 Pattern of tractor use

Plowing and harrowing, both on farm and off farm, is one of the most common uses of the tractors. Actual tractor use in terms of hours used per tractor per year is shown in Table 3. Note that there is a decreasing trend in the total number of hours used per year. This was due in part to the increase in the number of tractors in the area and in the reluctance of the farmers to hire out their tractors for fear of breakage.

Figures 1 and 2 show the number of tractors by hours worked and the number of tractors by area served during the last year of the study. Most of the tractors were used for less than 500 hours and are serving less than 10 hectares per year.

4.0 TRACTOR VS. CARABAO

4.1 Physical requirements

The carabao or water buffalo is a semi-aquatic animal of the bovine family belonging to the Bos bubalis species.[6] The tractor can work continuously as long as the man walking behind or the operator does not tire, but the carabao cannot. While the tractor needs grease, lubrication and repairs, the carabao needs feed, care and medical attention all year round. Engines do not consume fuel when not in operation while animals need feed and attention even if not in motion. Machines should be stored indoors and protected from damaging effects of water, sunlight and manure. Carabaos, on the other hand, can stay under big trees around the house. While specific skill is required for tractor operation, carabaos are easily trained and have a quiet disposition.

4.2 Cost comparison

There is no accurate and standardized cost calculation of keeping a carabao in the farm and so it is very difficult to accurately compare the cost of using a carabao to that of a hand tractor in land preparation. In this paper, costs are classified into two major groups: 1) fixed, and 2) variable costs.

6/ Buranamanas, P., "A Survey of Buffalo in Thailand," Paper published by Kasetsart University and Kasetsart/Hawaii Contract in cooperation with USOM, Thailand, 1963.

TABLE 3. Average number of hours used per tractor per year by crop year, Laguna, 1964-1969.

Crop year	Hours used per year		
	On farm	Off farm	Total
1964 - 65	376.8	146.4	523.2
1965 - 66	252.8	236.8	489.6
1966 - 67	232.8	216.0	448.8
1967 - 68	224.0	168.8	392.8
1968 - 69	188.0	156.8	344.8

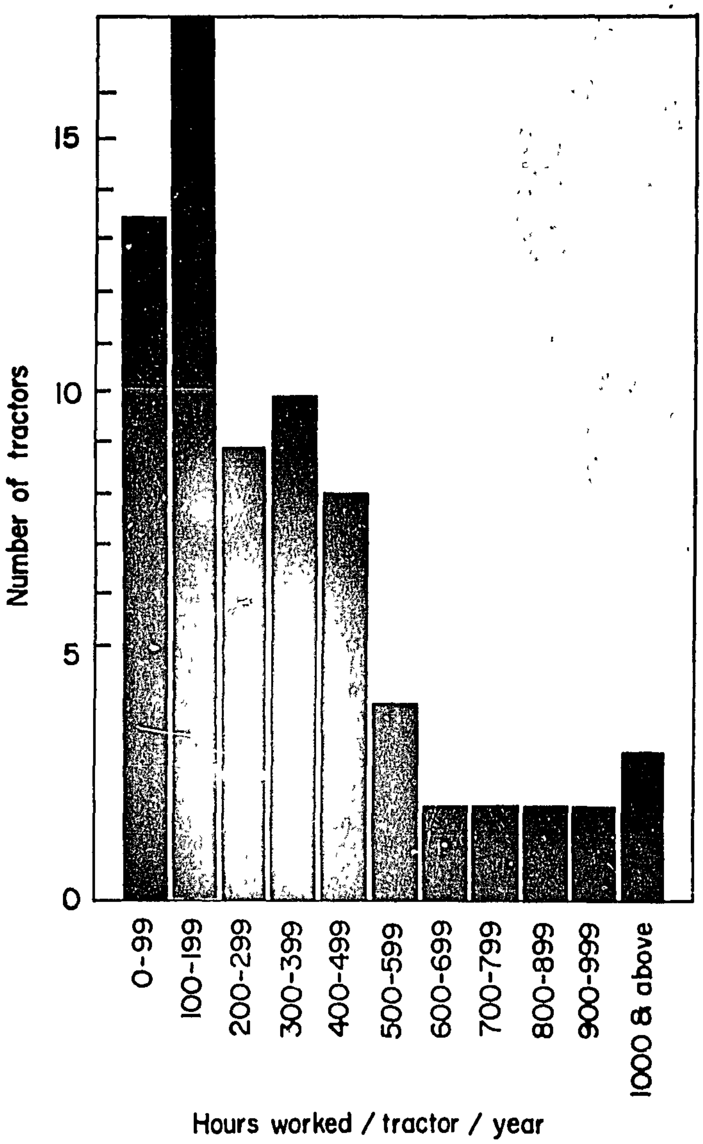

Fig. 1. Number of tractors by hours worked per tractor per year, 73 hand tractors, Laguna, 1968-69.

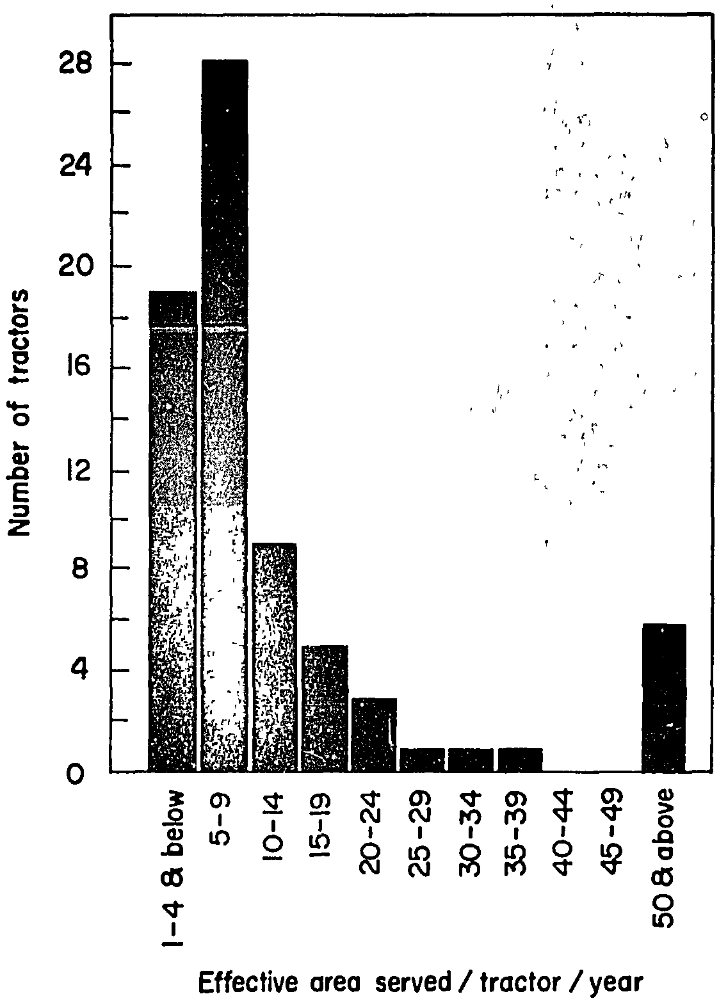

Fig. 2. Number of tractors by effective area served per tractor per year, 73 hand tractors, Laguna, 1968-69.

Table 4 indicates the individual cost items considered under each group. The result of cost curve analysis for the tractor using the above data is shown in Figure 3. This cost curve indicates a greater reduction in cost when used on a greater area, because fixed costs are spread over a number of hectares. There are economies of scale in tractor ownership: the more fully employed a tractor is, the lesser is the cost per hectare served.

At a custom rate of ₱120 per hectare, with 12 percent interest cost and 7 years' life, a tractor breaks even if used in an effective crop area of approximately 12 hectares. At this point it is just covering total cost. So in order to make more, it must be able to reduce cost by serving a greater area. If a farmer has only a crop area of 5 hectares, naturally it is not advisable for him to buy a tractor; however, if he rents it out and serves 10 hectares or more, his decision to purchase one would be more justified. It is difficult to find sufficient work on any farm to occupy tractors fully throughout the year, but it may be of great importance to achieve the maximum possible output of work or to keep tractors as fully occupied as possible so that the fixed cost is shared as widely as possible.

The carabao cost curve is shown in Figure 4. Because of its physical nature it was assumed that the maximum area that a carabao can work on in a year is only 10 hectares. This assumption is based on the findings of the study where land preparation extends for more than 3 months or approximately 102 days per season. If a hectare of rice land is plowed and harrowed for 20.56 days, then the area that a carabao can work on in a year is approximately 10 hectares.

Hiring a man with an animal on a per hectare basis is not very common. Rather, farmers hired them on a daily basis. Farmers value the work of animal and man equally, so that if the rental rate is ₱8 per day, half of the amount is for the animal.

As previously mentioned, a hectare of lowland rice is plowed and harrowed with the use of a carabao in 20.56 days. At the rate of ₱8 per day, preparing a hectare will cost ₱164. In the case of the carabao, there is minimal reduction in total cost even if a wider area is serviced.

4.3 Labor productivity

Increased productivity of labor brought about by introduction of machinery is one of the ultimate goals in rice farming. The effects of mechanization on labor use are generally conflicting. While the use of more efficient power tillers would reduce labor requirements, it could also enable farmers to farm more land or enable them to spend more time on other farm work. This would depend on what farmers actually do with labor saved in land preparation. This study reveals that a total of 7 man-days per hectare were saved when a tractor was

TABLE 4. Data used for cost curve analysis.

Cost item	Tractor	Carabao
	Pesos per tractor/or per carabao/year	
Fixed cost per tractor:		
Interest and depreciation	₱748.75	₱59.09
Variable costs per hectare:		
Fuel and oil	15.28	-
Repairs	10.35	-
Labor	36.56	61.68

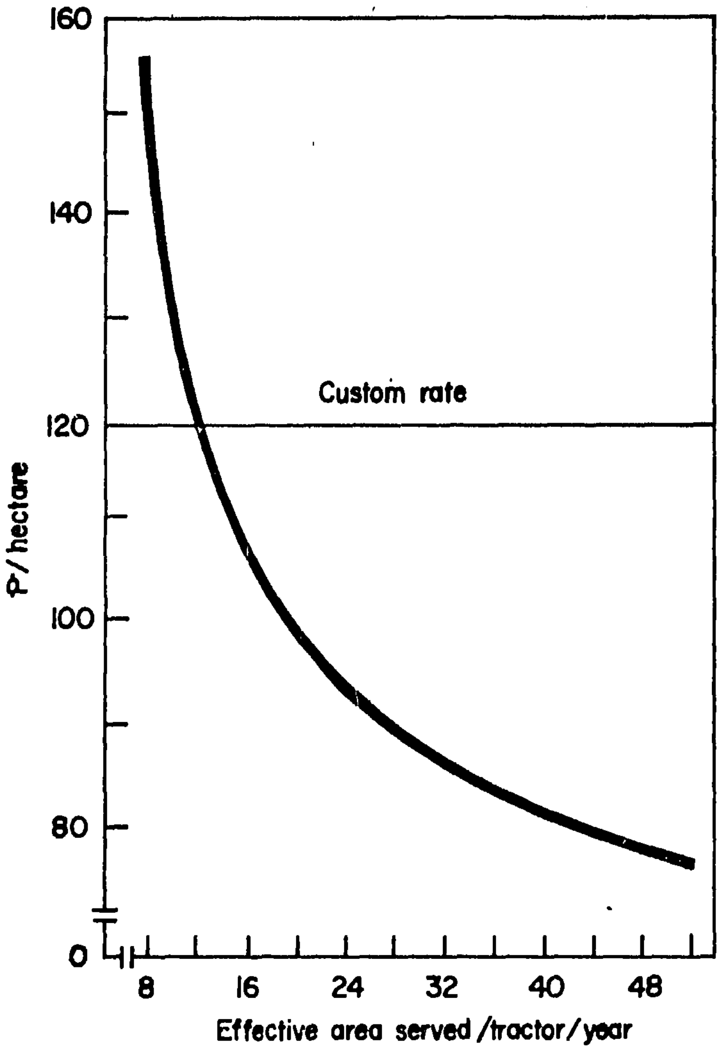

Fig. 3. Cost of using hand tractor based on an average operating cost of 50 farms in Laguna, 1968-69 and an assumed estimated life of 7 years.

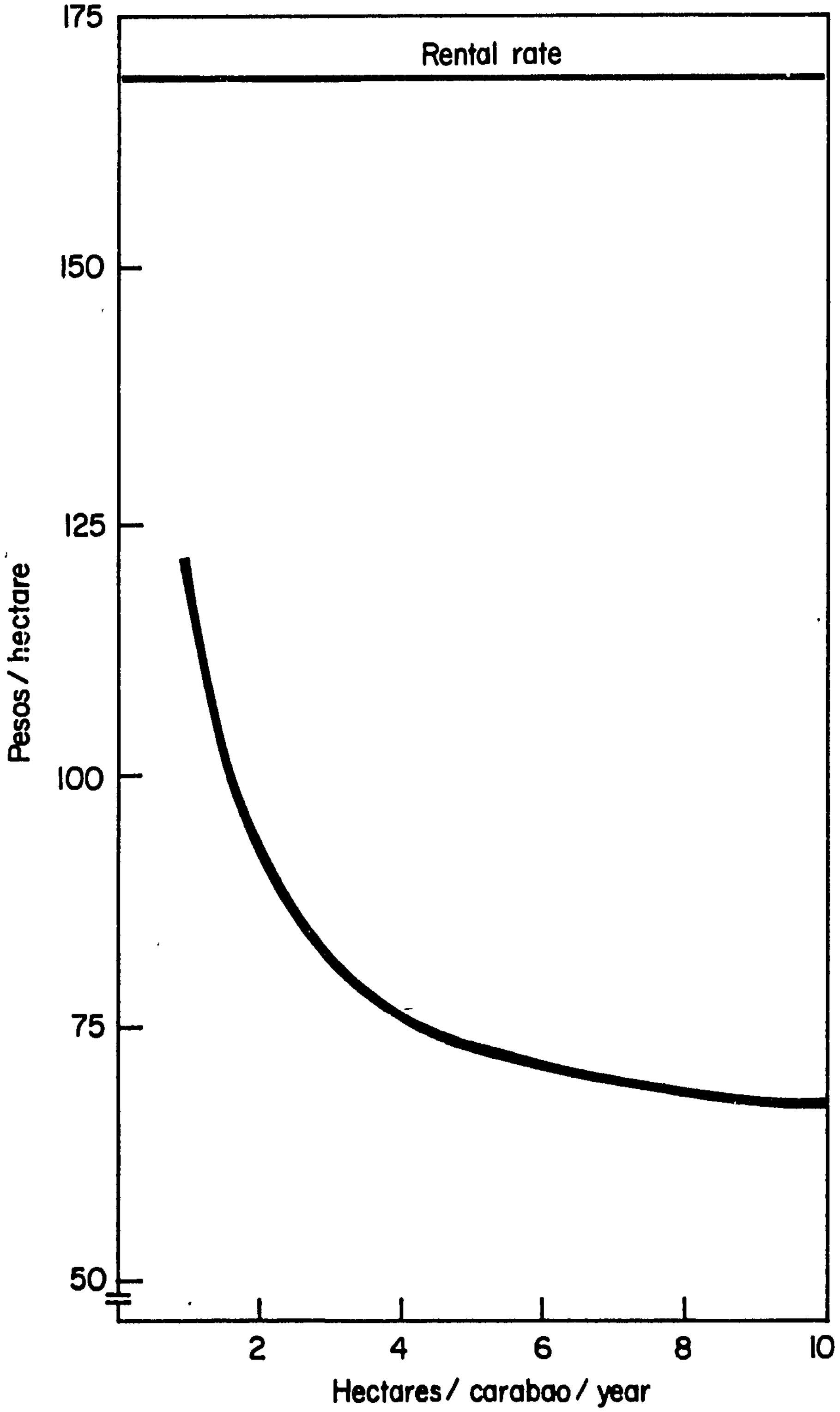

Fig. 4. Cost per hectare by area worked per carabao per year.

used instead of a carabao in land preparation. Farmers in the area studied, particularly in the municipality of Victoria, had fishing and duck raising as another source of income, so that it is possible that labor saved in plowing and harrowing would be spent on these endeavors.

In considering the local farm situation, mechanization is economical only in certain cases, since it is not always possible to effectively substitute capital for labor in the physical sense. Because of the abundance of family labor and the presence of more than 2 work carabaos in most of the farms, they are not bothered by seasonal peak labor demands.

4.3.1. Labor productivity comparison. A measure of labor efficiency on lowland rice farms is the number of cavans (rough rice) produced per man-labor day of work. The total man-days employed in growing a hectare of rice is 74 on the tractor-operated farms and 77 on the carabao-cultivated farms. Using the same average output per hectare (55 cavans), one man-day of labor in tractor-operated farms yields 0.74 cavans while the yield on carabao-cultivated farms is 0.71 cavans.

It might be wise to take a closer look at plowing and harrowing alone because it is in these operations that greater reduction in man-labor occurred. A man can plow and harrow a hectare of rice farm with the use of a carabao in 21 days, while he can do the same work with the use of a hand tractor in only 13 days, or a difference of 7 man-days. Labor productivity calculation shows that there is a difference of 1.6 cavans per man-day of plowing and harrowing, which implies that the use of a tractor is more productive than the use of a carabao in land preparation.

4.4 Time element involved in tractor use

Timing is an important aspect which cannot be shown in cost curve analysis but is a major reason for tractor purchase. Farmers in Laguna normally do not plow the land immediately after harvest. They remain busy threshing, drying and selling crops. Meanwhile, the land dries up and becomes very hard. The farmers can break the soil only after the rain starts to fall. If the showers are late, the whole operation is delayed; late sowing of one crop naturally delays the planting of the succeeding crop. Furthermore, when the land preparation is delayed, the planting season is also delayed and all operations must be performed in a great hurry and thus they cannot be done satisfactorily.

Many of the farmers are late in planting due to the limited capacity of the carabao. In order to do the transplanting work earlier, land preparation must be done in a shorter period and this is only possible with the use of hand tractors. Tractors can be operated continuously, which is impossible with the carabao.

The hand tractor has another value which cannot be definitely calculated at the present time. That is, after harvesting the first crop, the tractor can prepare the land quicker than the carabao and thereby greatly increase the possibility of planting an intermediate crop of short growing period (corn, for example) that will increase the intensity of land utilization. There was, however, only one farmer interviewed who took advantage of this.

4.5 Tractor ownership and the farm resource situation

Some of the factors associated with tractor and carabao use are: 1) size of farm, 2) availability of irrigation, 3) source of credit, and 4) cost of operation. This section points out the particular resource situations found in each of the farms.

4.5.1. Size of farm. As noted in Table 2, farms using tractors were larger on the average than carabao-cultivated farms. This might be based on the fact that more income can be derived from larger farms necessary for tractor repayment and that larger farms demand more time and labor during periods of land preparation. On the other hand, carabao-cultivated farms were smaller and a carabao could easily do the work to catch up with planting time.

4.5.2. Availability of irrigation. The presence of irrigation in tractor-operated farms made possible the planting of 2 crops a year, hence it is likely that these farmers derived more income to warrant tractor purchase. And the fact that they also had larger farms made them more likely tractor-owners, not to mention the labor and time element involved in land preparation for the succeeding planting season.

4.5.3. Source of credit. This factor cannot be clearly identified in this study because the study was done in only one province and the source of credit is assumed to be the same.

4.5.4. Cost of operation. The main difference in the cost structures is the higher annual fixed inputs of tractors. As previously mentioned, tractor-operated farms were large double-crop-irrigated farms and, therefore, their income was likely to be higher. Thus, they became potential tractor-owners.

5.0 SUMMARY AND CONCLUSIONS

Agricultural mechanization is a world-wide trend in agricultural improvement. This was also observed in Laguna where much progress has been made in recent years in adopting modern farm machinery, specifically the hand tractor, in small scale agriculture. The walking type of hand tractor is most widely used because of its adaptability to lowland paddy cultivation. Plowing and harrowing are the most common jobs performed.

Hand tractors are usually purchased in cash or on installment basis, from local agents. Most of the farmers bought hand tractors from their own savings and crop sales, although 4 percent of them were purchased through the loans extended by the rural banks. Fifty percent of the newly purchased tractors during the fourth year of the study were financed by funds borrowed from the rural banks through the CB:IBRD loans. This is an indication that rural bankers played a major role in the introduction of hand tractors by providing credit through the World Bank loans. This government subsidy on tractor purchases contributed to the high growth rate in the introduction of hand tractors.

The reasons for tractor purchases are both economic and non-economic. The economic benefits derived from tractor use are associated with the reduction in the amount of time and labor required for land preparation. A considerable reduction in labor input is achieved in land preparation. The results of the analysis indicated that plowing and harrowing a hectare of rice land when using a tractor requires only 13 days, or 7 days less than when using a carabao. This is an indication that tractor purchases bring financial benefit through savings in labor.

Another economic benefit mentioned by tractor-owners is the additional income derived from tractor hire. They are aware of the fact that fixed costs could be spread by hiring out their tractors. However, as more farmers acquire tractors, with farm size relatively constant, income derived from custom work will be greatly reduced unless changes in cropping pattern are introduced.

The non-economic reasons for tractor purchases are associated with the nuisance factor of keeping and maintaining carabaos. Other reasons, however, are socially motivated by the prestige of owning a tractor.

The hand tractors are employed in double-crop-irrigated farms with an area more than double that of the carabao-cultivated farms (4.8 hectares as against 2.3 hectares). This is so because larger farms have greater paying capacity necessary in tractor ownership, as well as greater time and labor pressure required for the task of completing land preparation.

Analysis of cost per hectare tends to show that, on the average, the use of hand tractors will greatly depend upon area served. There is a need for bigger sized farms in order to lower cost of production and tractors will prove economical only if used on an optimum number of hectares at minimal cost.

The findings of the study further indicate that likely tractor demand will appear in areas where farms are larger than average and are double-crop-irrigated. These are the regions where mechanization is most likely to succeed.

BENEFITS AND COSTS OF INSECTICIDE USE FROM EXPERIMENTAL RESULTS

Abraham M. Mandac[1]

1.0 INTRODUCTION

It has long been realized that control of insect pests and plant diseases is a potent factor in raising production and lowering costs of agricultural production. This realization has led to the development and introduction of modern pesticides that find extensive use in the world today. For instance, Japan in 1965 saved an estimated total of 1.05 million tons in terms of brown rice after a successful campaign for insect protection.[2] Experiments conducted at the International Rice Research Institute and elsewhere in the Philippines have shown that plots receiving insect protection generally yielded from 1 to 3 ton/ha more than unprotected plots.[3]

In Southeast Asia, the stem borer coupled with leafhoppers and planthoppers that transmit virus diseases constitute the major problem in rice insect pest control. This group of insects has received major attention in the program of IRRI entomologists in previous years. The same group of insects are reported to constitute the major pests of rice in other parts of Asia.[4]

The introduction of granular systemic insecticide has brought about greater efficiency over the traditional methods of spraying and dusting, which are laborious because of short insecticidal periods. Of the great variety of insecticides screened at the IRRI, two systemic insecticides, lindane (γ-BHC, 6 percent active ingredient) and diazinon, have proved to be effective in controlling common rice insect pests. Findings on these insecticides have shown that for both, the frequency of application was more important in increasing grain yield than the rate of application. The rates of 1 kg/ha for diazinon and 1.5 kg/ha for lindane, applied every 20 days, appear to be the most appropriate for general field use.[5]

In an effort to gain some insights on the economic benefits derived from controlling insect pests, the Department of Agricultural Economics, IRRI, started its own experimentation with insecticides during the previous year. Initial experiments were conducted in the Institute farm. Results obtained proved unsatisfactory because of the atypical insect population at the IRRI farm. This prompted the Department to bring its experiments to the farm level during the 1968 wet season. Initial results of the latter have been reported late last year (Montaño, 1968).[6]

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[1] Research Aide, Agricultural Economics Department, The International Rice Research Institute.

[2] Ishikura, H., "Present Situation of Disease and Insect Pest Control for Important Crops," Plant Protection in Japan; 5, p. 33.

[3] International Rice Research Institute. 1967. Annual Report 1967. Los Baños, Philippines, p. 189.

[4] Ishikura, H., op.cit., pp. 32-33.

[5] IRRI Annual Report 1967.

This paper presents a preliminary report of the results of the field experiments conducted by the Department of Agricultural Economics, IRRI, in Calauan, Laguna during the 1969 dry and wet seasons.

2.0 OBJECTIVES

The experiments were designed to determine the effects of alternative levels and timing of insecticide application on the yields of lowland rice. In addition, a case study approach was utilized to determine the various practices of 12 farmer cooperators in Calauan, Laguna for controlling rice insect pests.

Specifically, the experiment was conducted to:

(1) determine the effect of varying levels and time of application of lindane and diazinon on grain yield and several other plant characteristics of lowland rice under field conditions.

(2) determine the effectiveness of lindane and diazinon when used to control stem borers, leafhoppers and planthoppers.

(3) determine the optimum level and time of application of the insecticides used.

(4) compare the experimental results with those obtained by farmer cooperators employing their own methods of controlling insect pests.

3.0 MATERIALS AND METHODS

Five different frequencies of lindane treatments - zero level or control, 2 kg/ha applied at 50 days after transplanting (DAT), 2 kg/ha at booting stage, 2 kg/ha at 50 and 80 DAT, 2 kg/ha at 80 DAT, were used in the dry season experiment. Diazinon was also applied in one treatment of 2 kg/ha at 50 and 80 DAT. The treatments were applied to three rice varieties, IR20, IR8 and Intan in the dry season and IR20, IR8 and C4-63 in the wet season. One application of lindane at 80 DAT was replaced with complete protection treatment (four applications of 2 kg/ha lindane at 15, 35, 55 and 75 DAT) in the wet season. Treatments are shown in Table 1.

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[6] Montaño, C., "Economics of Insecticide Use in Lowland Rice," IRRI Saturday Seminar, November 23, 1968.

Fertilizer level was fixed at 75 kg N/ha for both seasons. This was based on the most commonly used rate among farmers in the area. Split application was used with one-half put in as basal application one day before transplanting and the remaining half applied at about the booting stage of the plant.

Table 2 summarizes the cultural practices applied in the experiments.

A split-plot design in randomized complete blocks was employed. The varieties served as the main-plots and the sub-plots were those of the insecticide treatments. Each block was divided into three main-plots on which the varieties were assigned at random. Three blocks gave rise to three complete replications for each variety (Figure 1).

Six treatments were layed out in rows measuring 5 x 24 m; a sub-plot measured 5 x 4 sq.m.

The blocks were assigned to separate paddies in the farmer's field in an attempt to make the experiments highly representative of field conditions. However, their locations were determined by the location of the water supply with each successive treatment located further from the source (Figure 2).

4.0 RESULTS AND DISCUSSIONS

4.1 Experimental findings

4.1.1 Plant height and tiller number. Plant height and tiller number were obtained to determine the effects of the various treatments on plant growth. Emphasis was laid upon observations at harvest since their influence on yield appears to be more relevant.

The analysis of variance (ANOV) for plant height showed highly significant differences among varieties in both seasons. The use of Intan and C4-63, relatively tall varieties, each in combination with IR20 and IR8 which are short varieties, accounts for this. The ANOV also showed moderately significant effect of the various treatments. Complete protection plots (T5) in the wet season experiment consistently produced taller plants than all other treatments.

TABLE 1. Different treatments used with their corresponding costs, 1969 dry and wet seasons

Treatment	Insecticide	Rate of application (kg a.i./ha)	No. of application	Time of application (DAT*)	Total amount supplied (kg a.i./ha)	Per hectare cost[a]
			Dry Season			
T_1			CONTROL			
T_2	Lindane	2.0	1	50	2.0	47.00
T_3	Lindane	2.0	1	Booting	2.0	47.00
T_4	Lindane	2.0	2	50-80	4.0	94.00
T_5	Lindane	2.0	1	80	2.0	47.00
T_6	Diazinon	2.0	2	50-80	4.0	100.00
			Wet Season			
T_1			CONTROL			
T_2	Lindane	2.0	1	50	2.0	47.00
T_3	Lindane	2.0	1	Booting	2.0	47.00
T_4	Lindane	2.0	2	50-80	4.0	94.00
T_5	Lindane	2.0	4	15-35-55-75	8.0	188.00
T_6	Diazinon	2.0	2	50-80	4.0	100.00

* DAT - Days after transplanting.

[a] At ₱14.10 per 10 kg bag lindane (6%) and ₱50.00 per 20 kg bag diazinon (Basudin 10 G), each kilogram active ingredient costs ₱23.50 and ₱25.00, respectively.

TABLE 2. Cultural practices in the Calauan Field Experiment, 1969 dry and wet seasons.

Treatment/cultural practices	Dry Season	Wet Season
Land Preparation		
Plowing (no. of passes)	1	1
Harrowing (no. of passes)	3	3
Planting		
Variety	IR20, IR8, Intan	IR20, IR8, C4-63
Method of raising seedlings	Dapog	Dapog
Distance	25 x 25 cm	25 x 25 cm
Fertilizer application		
Kind	Ammonium Sulfate	Ammonium Sulfate
Rate	75 kg N/ha	75 kg N/ha
Timing	1/2 1-day before transplanting 1/2 at booting	1/2 1-day before transplanting 1/2 at booting
Weed Control		
Chemical		
Kind	2,4-D	2,4-D
Rate	0.15 l.a.i./ha	0.15 l.a.i./ha
Timing	20 DAT*	20 DAT
Mechanical		
Rotary weeding (no. of passes)	1	1
Hand weeding	2	2
Water management	Intermittent irrigation	Flooding

*DAT - days after transplanting

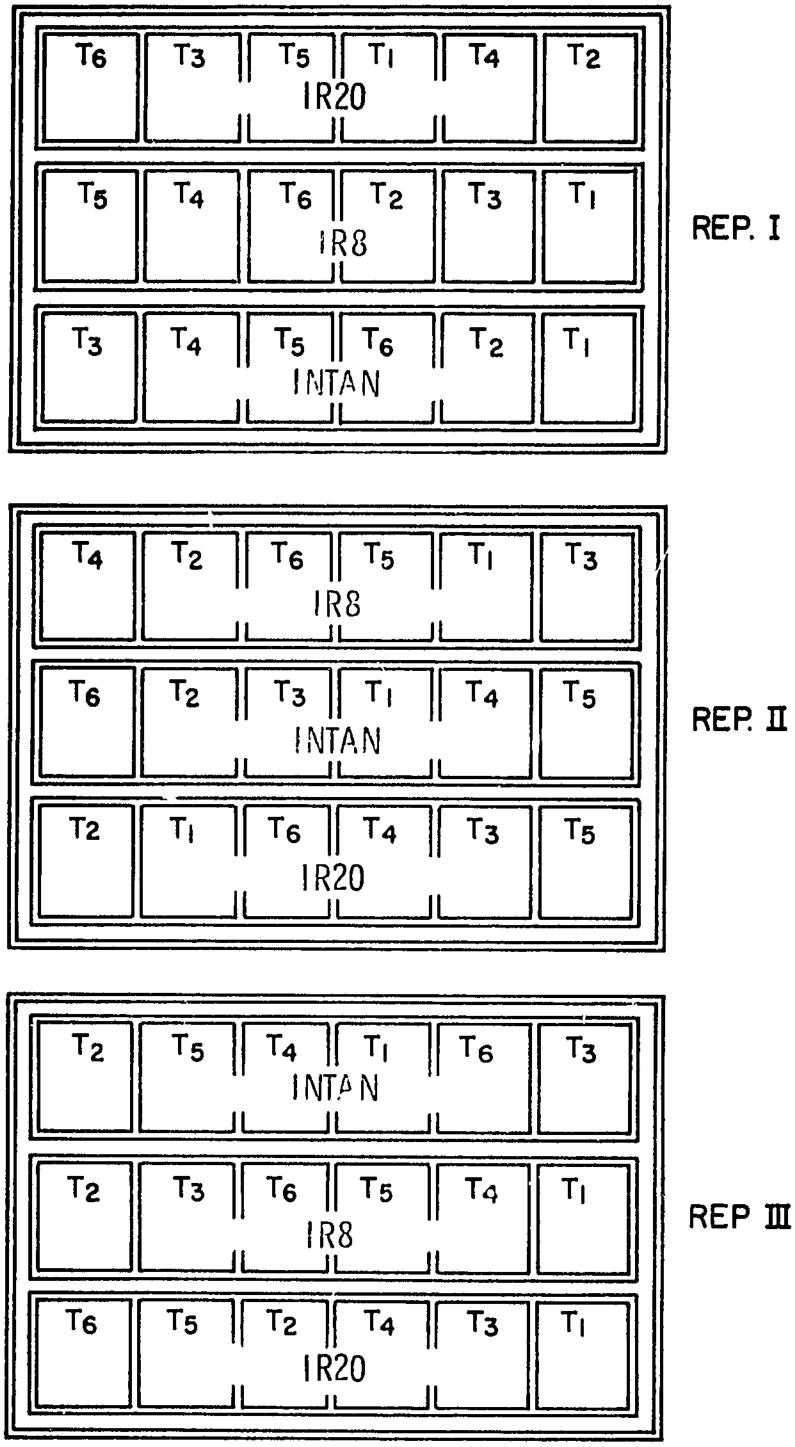

Fig. 1. Design of Field Experiment in Calauan, Laguna. 1969 Dry Season

LEGEND:

T_1 - untreated control
T_2 - one gamma-BHC application at 50 DAT.
T_3 - one gamma-BHC application at booting.
T_4 - two gamma-BHC applications (1 at 50 DAT and 1 at 80 DAT).
T_5 - one gamma-BHC application at 80 DAT.
T_6 - two diazinon applications (1 at 50 DAT and 1 at 80 DAT).

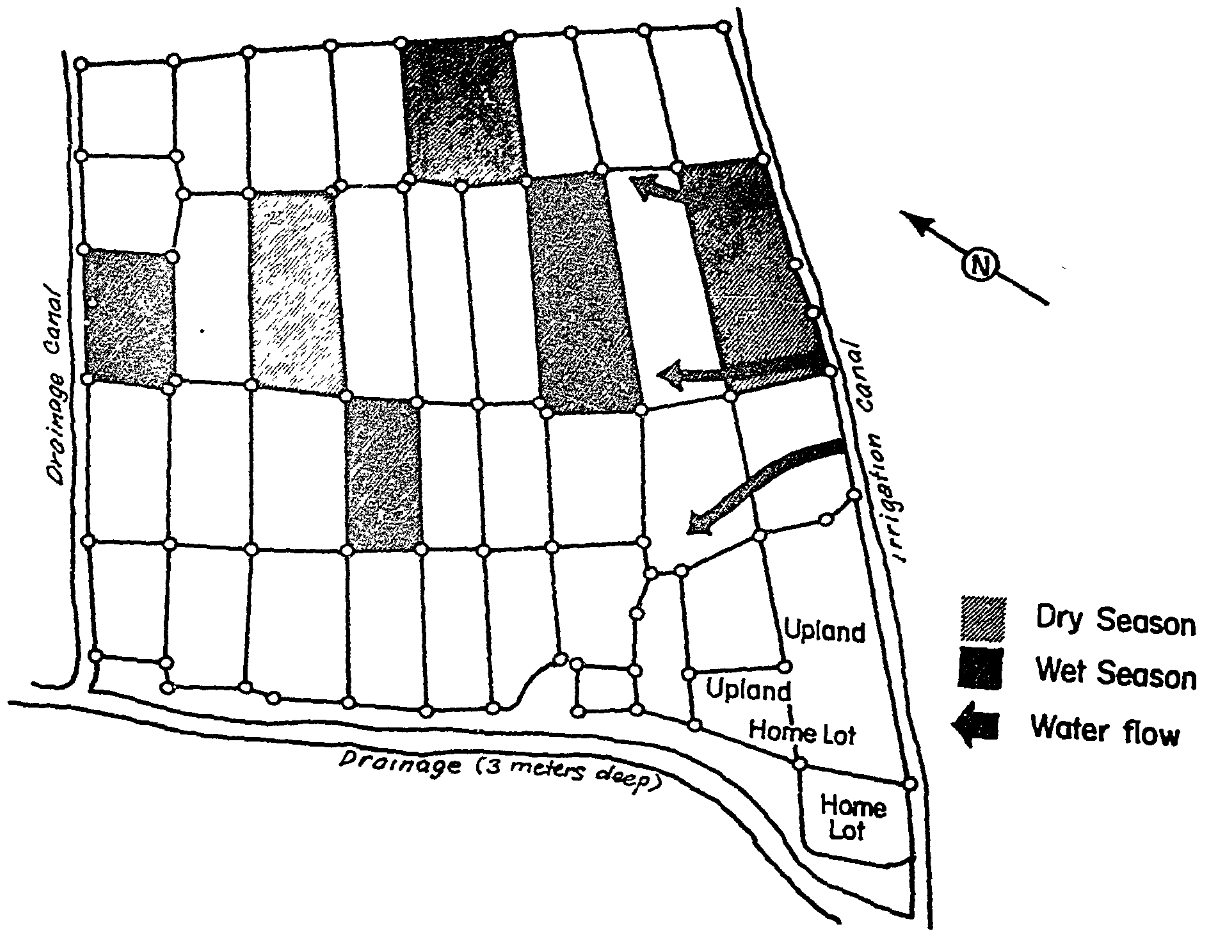

Fig. 2. Site of the Dept. of Ag. Economics Field Experiment, 1969 dry and wet seasons.

The ANOV for tiller count did not show any significant differences among varieties nor any significant effect of treatments in both season experiments. During the wet season, however, plants attacked by whorl maggot produced more tillers than those of the complete protection plots.

4.1.2 Dead heart and white head count. Analysis of variance was also employed to determine the effects of the insecticide on the pest. Stem borer attack was expressed in terms of percent dead hearts and percent white heads. Figures 3 and 4 show the development of borer damage during the dry and wet seasons, respectively.

The transformed ANOV for dead hearts at 65 days after transplanting showed highly significant effects of the various levels and frequencies of lindane and diazinon. In the dry season, plots treated with lindane at 50 DAT, lindane at 50 and 80 DAT and diazinon had statistically lower dead hearts count than the other treatments which did not vary from each other significantly (Table 3). Among varieties, IR8 appeared to have suffered the most, suggesting that the variety is the most susceptible. There were no varietal differences on dead hearts count during the wet season. (Table 4). The ANOV showed highly significant effects of the treatments, however, with the complete protection plots having practically no infestation.

The ANOV for white heads revealed highly significant differences among varieties with Intan suffering the highest infestation. With IR8 following, IR20 appeared to be the most resistant among the varieties to the second generation stem borer attack. The ANOV failed to show any significant effects of the treatments, however. The opposite was true during the wet season with the ANOV showing no differences among varieties, but showing significant effects of the various treatments.

4.1.3 Leafhopper count. Leafhopper samples were obtained at 75 DAT to determine their abundance in the experimental plots and, hence, to determine the effectivity of lindane and diazinon when used to control leafhoppers.

There were no varietal differences on leafhopper count in both seasons. Significant effects of the various treatments on their abundance was observed from both seasons, however. Diazinon-treated plots recorded statistically lower number of leafhoppers than all other plots (Table 3). The same was true during the wet season. Two applications of diazinon were comparable with 4 applications of lindane.

4.1.4 Yield analysis. The degree of insect infestation and yields as affected by various levels of lindane and diazinon are shown in Table 3 (dry season) and Table 4 (wet season). The same relationships between insect

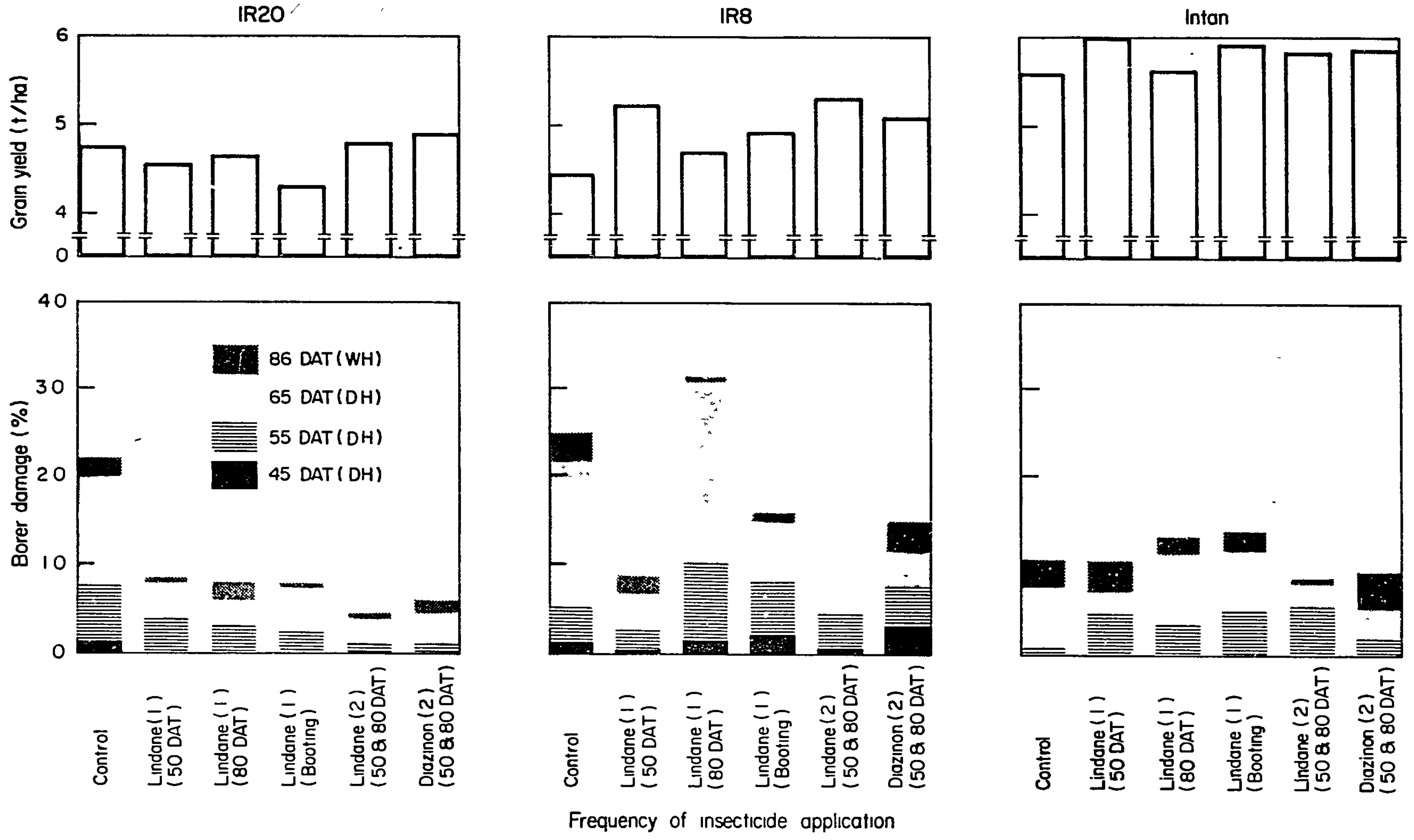

FIG. 3. Development of borer infestation and yields in three rice varieties under various frequencies of insecticide application, Calauan, Laguna, 1969 dry season.

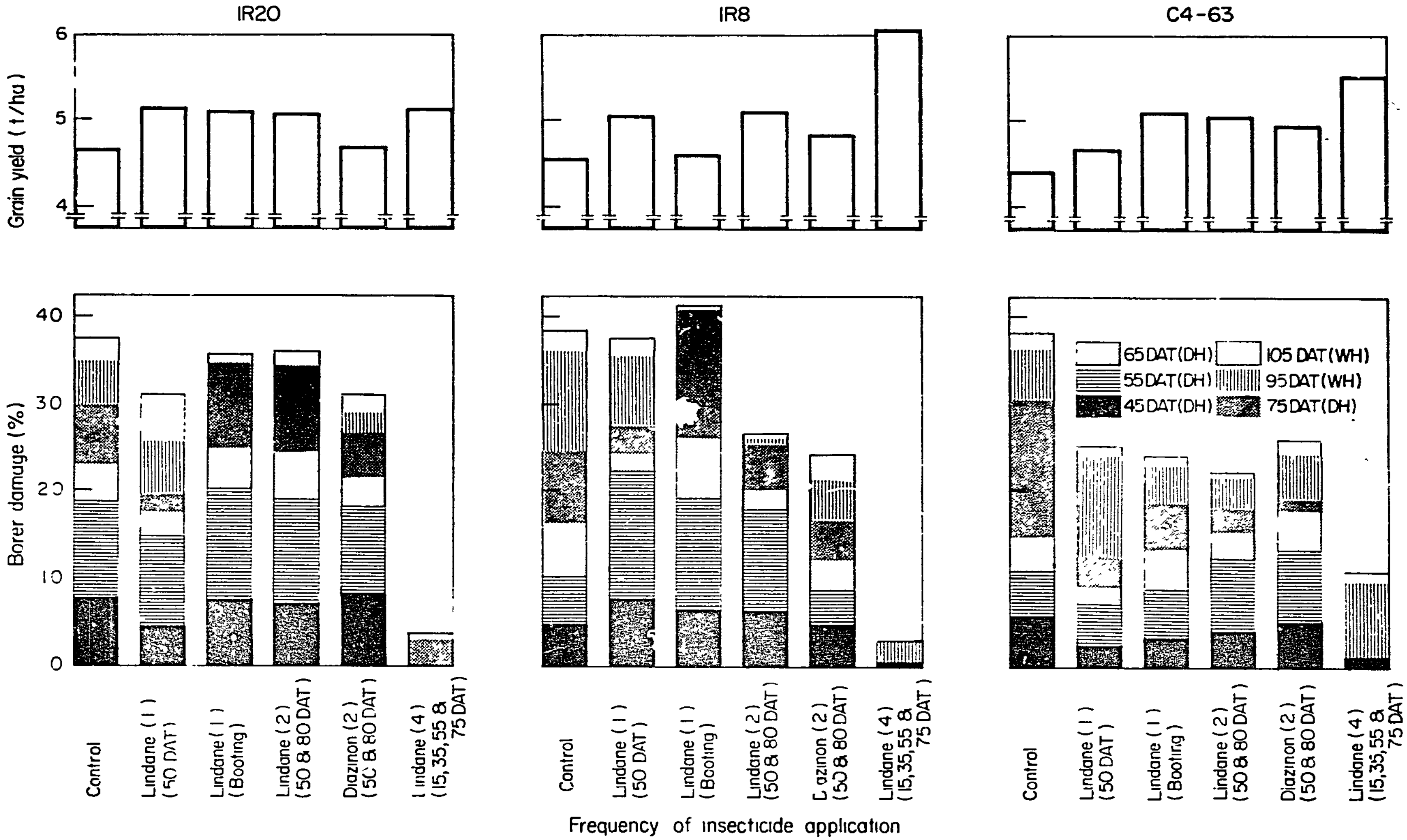

FIG. 4. Development of borer infestation and yields in three rice varieties under various frequencies of insecticide application, Calauan, Laguna, 1969 wet season

TABLE 3. Effects of various levels and frequencies of lindane and diazinon on insect pest control, 3 rice varieties, Calauan, Laguna, 1969 dry season.[a]

Treatment	Dead hearts (%)[b]	White heads (%)	Leaf-hoppers[c]	Grain yield (kg/ha)[d]
		86*	75*	
		IR20		
Control	1.87	.12	13.3	4759
Lindane - 2 kg/ha at 50 DAT	.81	.01	35.0	4564
Lindane - 2 kg/ha at booting	.75	.04	14.0	4314
Lindane - 2 kg/ha at 50 & 80 DAT	.41	.02	23.0	4814
Lindane - 2 kg/ha at 80 DAT	.61	.20	10.7	4629
Diazinon - 2 kg/ha at 50 & 80 DAT	.41	.16	2.3	4907
		IR8		
Control	2.04	.32	14.3	4454
Lindane - 2 kg/ha at 50 DAT	.66	.22	22.3	5224
Lindane - 2 kg/ha at booting	1.27	.08	20.3	4896
Lindane - 2 kg/ha at 50 & 80 DAT	.80	0	16.0	5330
Lindane - 2 kg/ha at 80 DAT	2.95	.02	13.7	4734
Diazinon - 2 kg/ha at 50 & 80 DAT	.81	.36	4.0	5068
		Intan		
Control	.79	.28	4.0	5618
Lindane - 2 kg/ha at 50 DAT	.73	.33	20.0	6026
Lindane - 2 kg/ha at booting	1.27	.19	10.7	5964
Lindane - 2 kg/ha at 50 & 80 DAT	.83	.05	17.0	5852
Lindane - 2 kg/ha at 80 DAT	1.16	.19	12.7	5659
Diazinon - 2 kg/ha at 50 & 80 DAT	.55	.40	2.0	5864

[a] Average of 3 replications.

[b] Summation of two counts at 54 and 64 days after transplanting.

[c] Number/20 sweeps.

[d] Multiple range test for yield

IR20 - no significant difference among treatments

IR8 - 4454 4734 4896 5068 5224 5330

Intan - 5618 5659 5852 5864 5964 6026

TABLE 4. Effects of various levels and frequencies of lindane and diazinon on insect pest control and yields of 3 rice varieties, Calauan, Laguna, 1969 wet season.[a]

Treatment	Whorl maggot index	Dead hearts(%)[b]	White heads(%)[c]	Grain[d] yield(kg/ha)
	45*			
		IR20		
Control	1.7	1.54	.75	4641
Lindane - 2 kg/ha at 50 DAT	1.3	1.31	1.15	5165
Lindane - 2 kg/ha at booting	1.7	1.75	.04	5132
Lindane - 2 kg/ha at 50 & 80 DAT	2.3	1.76	.14	5111
Lindane - 2 kg/ha at 15, 35, 55, & 75 DAT	0	0	.36	5136
Diazinon - 2 kg/ha at 50 & 80 DAT	1.8	1.31	.47	4679
		IR8		
Control	3.3	1.17	1.38	4569
Lindane - 2 kg/ha at 50 DAT	3.3	1.67	1.01	5050
Lindane - 2 kg/ha at booting	3.3	1.97	.21	4632
Lindane - 2 kg/ha at 50 & 80 DAT	4.0	1.38	.11	5153
Lindane - 2 kg/ha at 15, 35, 55, & 75 DAT	0	0	.24	6107
Diazinon - 2 kg/ha at 50 & 80 DAT	3.0	0.76	.76	4844
		C4-63		
Control	1.2	.88	.75	4391
Lindane - 2 kg/ha at 50 DAT	1.7	.67	1.29	4661
Lindane - 2 kg/ha at booting	1.3	1.01	.84	5066
Lindane - 2 kg/ha at 50 & 80 DAT	1.7	1.12	.42	5044
Lindane - 2 kg/ha at 15, 35, 55, & 75 DAT	0	.02	.65	5524
Diazinon - 2 kg/ha at 50 & 80 DAT	1.3	1.28	.93	4940

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a/ Average of 3 replications.

b/ Summation of two counts at 55 and 65 days after transplanting.

c/ Summation of two counts at 95 and 105 days after transplanting.

d/ Multiple range test for yield

IR20 -	4641	4679	5111	5132	5136	5165
IR8 -	4569	4632	4844	5050	5153	6107
C4-63-	4391	4661	4940	5044	5066	5524

infestation and yield are shown graphically in Figure 3 (dry season) and Figure 4 (wet season). The graphs make it somewhat easier to visualize the degree of damage due to stem borer attack as reflected in the dead heart and white head counts.

During the dry season the significantly higher yields obtained for Intan as compared with IR8 and IR20 did not appear to be associated with differences in the degree of stem borer damage or leafhopper infestation. Stem borer damage was light. Even on the most heavily infested plots, total damage did not exceed 3 percent. The multiple range test (bottom of Table 3) shows that for IR20 insecticide treatments had no effect upon yield, while for Intan and IR8 yield tended to be significantly greater than the control on those plots receiving treatment at 50 days after transplanting. Note that the bulk of the stem borer damage is reflected in the dead heart counts at 55 and 65 days after transplanting (Figure 3).

During the wet season stem borer damage was somewhat higher than in the dry season as is normally the case in this area. Again, IR20 showed relatively little response to insecticide treatments. The control and diazinon treatment yields were significantly lower. But in spite of the short reduction in stem borer damage due to four applications of lindane, no significant yield increase was obtained over treatments of one and two applications of lindane. By contrast, for both IR8 and C4-63 yields in general responded to higher applications of insecticide. IR8 showed the most significant response with a 1-1/2 ton yield increase between the control and the application of four lindane treatments. However, it is possible that this yield increase could have been in part due to the control of whorl maggot (Table 4) or other insects.

In summary, it would appear that increases in yield were in accordance with reduction in stem borer damage, but the relative increase was far less for IR20 and Intan than for IR8 and C4-63. It is also clear that factors other than stem borer damage may have influenced yields.

4.2 Farmers' fields

Table 5 shows levels of borer infestation in terms of percent dead hearts and percent white heads and yields obtained from farmer cooperators in Calauan for two seasons. Farmers' fields suffered only slight borer attack during the dry season. A slightly higher infestation occurred during the wet season. Also, it should be pointed out that infestation levels observed from these farms were comparable with those obtained from our experiments.

We cannot as yet make any comparisons between the results gathered from cooperator farms and our experiments. One reason for this is our lack of knowledge on the variability existing within farms in terms of infestation

TABLE 5. Stemborer infestation levels (% dead hearts, % white heads) and grain yields of farms using foliar spray for rice insect pest control.[a] Calauan, Laguna 1969 dry and wet seasons, (average of 5 observations per farm).

Farm No.	Variety	White heads (%) at harvest	Grain yield (kg/ha)	Variety	Dead hearts (%)[b]	White heads (%)[c]	Grain yield (kg/ha)
	Dry season			Wet season			
A_1	Intan	0.34	4758	IR20	1.26	1.17	4293
A_2	Intan	0.01	6295	IR8	1.42	1.82	5679
A_3	Intan	0.14	5963	IR8	2.08	1.06	3768
A_4	Intan	0.24	4949	IR8	1.59	2.36	3122
A_5	Intan	0.52	5373	IR8	3.92	1.73	4496
A_6	IR8	0.11	5963	IR8	2.17	1.52	3648
B_1	Intan	0.19	4809	C4-63	1.98	0.23	4563
B_2	Intan	0.18	5574	C4-63	1.01	0.71	3486
C_1	Intan	0.51	4547	IR8	1.74	1.41	3504
C_2	C4-63	0.44	5262	IR5	3.05	0.60	5148
C_3	Glutinous	2.06	3348	IR5	2.67	1.32	4889

[a] Thiodan (35% E.C.) on the average of 0.15 liter/ha applied at 35 days after transplanting is the most common practice.

[b] Summation of three counts at 45, 55 and 65 days after transplanting.

[c] Summation of two counts at 95 and 105 days after transplanting.

resulting from our incomplete control of the farms. We have gathered some data that would give us information on the variability existing within farms and among farms during the wet season.

4.3 Some economic implications of the experimental results

Table 6 shows the net profits, or losses from the application of insecticides. The net profits occupy the upper left hand corner of the boxes and their respective benefit/cost ratios appear at the lower right hand corner. In the dry season, highest net profits of P225 and P111 for IR8 and Intan, respectively, were obtained at yields of 5224 and 6026 kg/ha. These resulted from one application of lindane at 50 days after transplanting. No inference can be made on IR20 owing to rat damage nearing harvest.

During the wet season, highest net profits were derived from treatments producing the highest yields on all varieties. IR8 and C4-63 realized profits of P367 and P300, respectively, and their benefit/cost ratios were 1.96 and 1.60 from 4 applications each of lindane at 15, 35, 55 and 75 days after transplanting. One application of lindane at 50 DAT gave the highest profit on IR20 at the yield of 5165 kg/ha.

One will see from Table 6 that the average benefit/cost ratios of the treatments decreased as the number of application was increased. For example, during the dry season, one application of lindane at 50 DAT on IR8 yielded a B/C ratio of 4.76. Two applications derived a little less net profit, consequently bringing down the ratio to 2.30. That highest profits could be obtained from just one application was also shown by this particular example. Such results only emphasize the importance of timing in the application of insecticides in order to derive the maximum economic benefits.

From these results one would also observe that the economic optimum level of application varied with season and variety. This is understandable considering the very high degree of variability of insect infestation not only from season to season and from year to year, but also from one location to another.

5.0 SUMMARY

The limited number of experiments on insecticides conducted outside the Institute farm has given us some insights on the economic aspects of insecticide use. What these experiments have proved, so far, is that the rate and time of application are important assuming that insect pests are present in damaging proportions. Determination of economic levels of insecticide use is

TABLE 6. Per hectare net profits or (losses) from application of insecticides. (Average of 3 replications) Calauan, Laguna, 1969 dry and wet season.

Treatment	DRY SEASON			WET SEASON		
	IR20a/	IR8a/	Intanb/	IR20c/	IR8c/	C4-63c/
		(Pesos)			(Pesos)	
Control	0 0	0 0	0 0	0 0	0 0	0 0
Lindane - 2 kg/ha at 50 DAT	(46.70) 0	224.98 4.76	110.97 2.37	189.10 4.04	126.46 2.70	69.40 1.48
Lindane - 2 kg/ha at booting	(46.70) 0	108.98 2.33	87.00 1.86	174.25 3.73	(24.02) 0	243.55 5.21
Lindane - 2 kg/ha at 50 & 80 DAT	(22.44) 0	215.40 2.30	(2.92) 0	118.10 1.26	116.84 1.25	187.39 2.00
Lindane- 2 kg/ha at 80 DAT	(1.26) 0	52.02 1.11	(30.95) 0	-	-	-
Lindane- 2 kg/ha at 15, 35, 55 & 75 DAT	-	-	-	35.95 .19	366.88 1.96	300.39 1.60
Diazinon - 2 kg/ha at 50 & 80 DAT	(47.52) 0	116.64 1.16	(4.98) 0	(82.90) 0	(1.00) 0	136.07 1.36

a/ ₱16.00/cavan based on farm price during harvest.

b/ ₱17.50/cavan

c/ ₱20, ₱16, ₱19 per cavan for IR20, IR8 and C4-63, respectively.

complicated by a multiplicity of factors, foremost of which is the high degree of variability of insect occurrence and infestation. Determining the probability of a given infestation level requires an improved knowledge of insect ecology plus a series of data which can only be achieved through years of continuing research.

DECISION-MAKING WITH RESPECT TO THE USE OF INPUTS ON LAGUNA FARMS

Randolph Barker and Violeta G. Cordova[1]

1.0 INTRODUCTION

The report presented here is preliminary in nature. The data are still in the process of being gathered and analyzed. It was thought, however, that it would be useful to discuss some of our findings and observations.

The objective of the study is to determine the factors influencing the use of cash crop inputs such as fertilizer on 30 Laguna farms. Emphasis is placed on understanding the decision-making process with particular reference to the changes that have occurred since the introduction of new varieties. This requires an understanding of the landowner-tenant system of cost sharing and use of credit. The particular facets of the problem being investigated are:

(1) the identification of the individual responsible for the decisions.

(2) the relationship between decision-making and the availability and use of credit.

(3) the general nature of the demand for increasing the quantity or level of inputs.

(4) the risk preference of the decision-maker.

A principal question to be answered is whether or not the quantity of fertilizer and other inputs used depends upon restrictions imposed by the tenant as a borrower or the landowner as a lender. The hypothesis is that the landowner sets the restriction directly or indirectly, by limiting the supply of credit.

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[1] Agricultural Economist and Research Assistant, Department of Agricultural Economics, International Rice Research Institute.

It is further hypothesized that the decision of the landowner, as a principal supplier, to extend more credit to the tenant contributed materially to the increase in farm yields with the introduction of new varieties. Our study does not attempt to consider the social justice of the farm decision-making system, but merely its economic functioning.

1.1 Procedure

From the original Laguna sample of 155 farm operators, 30 were selected and interviewed twice. The landowners of each of the tenants were also interviewed twice (to date only 26 of the 30). The size of rice land for both groups is shown in Table 1. Questions in these interviews concerned principally decision-making and the use of credit. A third interview is being conducted with 10 tenants and the corresponding landowners to establish their risk preference. A utility curve for money is being derived for each individual following the procedures set forth by Makeham, Halter, and Dillon.[2/] Results of this third interview are not reported here.

2.0 FINDINGS

Tenants and landowners questioned separately were in almost complete agreement as to who was responsible for decisions regarding the kind and amount of inputs to use. In the majority of cases, the tenant makes the decision, as

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[2/] Professional Farm Management Guidebook No. 6, Best-Bet Farm Decisions by J. P. Makeham, A. N. Halter and John L. Dillon, Dept. of Farm Management, University of New England, Armidale, Australia, 1968.

TABLE 1. Hectares of rice owned by 28 landlords and operated by 28 tenants, ranked by size of holding, Laguna, 1969.*

Sample No.	Hectares of rice owned	No. of tenants	Average hectarage per tenant	Hectarage per tenant surveyed
1	0.33	1	.33	0.33
2	0.75	1	.75	0.75
3	1.50	1	1.50	1.50
4	1.50	2	.75	1.2
5	1.75	1	1.75	1.75
6	2.00	1	2.00	2.00
7	3.00	2	1.50	1.00
8	3.00	2	1.50	1.75
9	3.20	2	1.6	1.2
10	3.33	1	3.33	3.33
11	4.00	3	1.33	1.25
12	4.50	4	1.13	1.0
13	5.00	2	2.25	2.25
14	8.75	4	2.19	1.4
15	11.0	4	2.75	2.0
16	14.0	8	1.75	3.0
17	14.0	7	2.0	2.0
18	15.0	6	2.5	2.0
19	16.0	8	2	2.0
20	17.0	8	2.1	1.7
21	19.5	6	2.6	3.0
22	20.0	7	2.9	4.0
23	22.0	17	1.3	1.8
24	24.0	7	3.4	2.8
25	30.0	10	3.0	2.5
26	33.0	7	4.7	3.5
27	50.0	7	7.1	3.0
28	50.0	25	2.00	1.4

* Source: Tenant and landlord's survey.

shown in Table 2. The landowner comes to the farm only three or four times a crop season. In the few cases where the landowner is actively participating in the decisions, he visits the farm on the average about once a week.

Crop production loans were made to the largest number of tenants for fertilizer, chemicals, and transplanting, as shown in Table 3. A smaller number borrowed for land preparation, weeding, and fuel to run pumps. Table 4 illustrates the dominant position of the landowner as a source of credit. The usual procedure is for the landowner to supply inputs such as fertilizer at the time when they are needed, and to supply the cash for payment to hired labor. The repayment is made at harvest time, by setting aside enough rice to pay for the inputs provided by the landowner before the fifty-fifty sharing takes place. Under this system, it is virtually impossible to determine the rate of interest being charged. Many landowners indicate that they charge no interest. Some determine the repayment to be made based upon the value of rice at the time the input was purchased.

The landowner himself, in the majority of cases, did not find it necessary to borrow money to lend to the tenants (Table 5). Eight landowners borrowed money from the banks for loans on cash operating expenses, and almost as many borrowed to invest in pumps or other capital items. Many of the landowners are engaged in some form of business or profession outside of agriculture. Even for those borrowing from banks, the major source of borrowed funds was frequently for business activities not connected with the farm. As Table 1 shows, the majority of these landowners do not have large agricultural holdings.

TABLE 2. Decision on kind and amount of cash inputs, 30 farm operators, Laguna, 1969.*

Who makes decision	Fertilizer		Insecticide		Weedicide	
	Kind	Amount	Kind	Amount	Kind	Amount
			(No. reporting)			
Landlord	2	0	1	0	1	0
Tenant	23	26	24	25	24	25
Both	5	4	4	4	4	4
Total	30	30	29	29	29	29

* Tenant and landlord's survey.

TABLE 3. Crop production loan per hectare to 30 tenant farmers Laguna, 1969, wet and dry seasons.*

	No. reporting	Wet season	No. reporting	Dry season
		(₱)		(₱)
Fertilizer	22	56	16	58
Chemicals	22	16	16	16
Land preparation	13	109	10	86
Transplanting	18	56	11	42
Weeding	7	75	6	50
Others	10	59	10	68

* Source: Tenant's survey.

TABLE 4. Source of loans for crop production, 30 tenants, Laguna, 1969.*

Source	Number borrowing
Landowner	27
Money lender	2
Private	4
Rural Bank	2
None	2

*Source: Tenant's survey.

TABLE 5. Source of landowner's funds for lending to tenant, Laguna, 1969.*

Items	Rural Bank	Dealer	Personal savings	Others	Tenants not borrowing
Fertilizer	6	1	12	3	3
Chemicals	6	3	11	2	3
Transplanting	4	-	14	1	6
Land preparation	2	-	11	1	11
Investment (Tractor, pump, carabao)	7	-	7	1	10
Home consumption	1	-	15	-	9

* Source: Landowner's survey.

Nine of the 30 tenants interviewed indicated that some form of restriction or ceiling was imposed on the amount that they could borrow. Sometimes the upper limit was expressed on a farm basis, and sometimes on a specific item basis (Table 6). To determine the relationship between this restriction, the amount of inputs used, and the farm yields obtained, a comparison was made between the restricted and unrestricted farms. The results of the comparison are shown in Table 7. There is a suggestion that restrictions may have limited dry season production.

The combined impact of the new varieties plus higher rice prices on input use is shown by comparing the input levels for 1965 vs. 1969. The 20 landowners reporting indicated that on the average loans per hectare to their tenants had been increased from ₱83 to ₱245 in this period. Only 2 of the 26 tenants borrowing from landowners indicated that there had been no increase in the amount of credit extended. The change in credit extended on specific items as reported by the tenant is shown in Table 8. Both the number of landowners extending credit and the amount of credit increased for all items. The increase in loans for contract labor exceeded that for fertilizer and chemicals. The most dramatic change came in the case of land preparation, where custom hiring of tractors appears to be a substituting for farm-owned carabao.

Table 9 shows the capital investment in farm implements and farm power. The bulk of this investment was made without the use of credit on the part of the tenant. All but two of the 15 irrigation pumps are owned by the landowner. Hand tractors and carabao on the other hand are owned by the

TABLE 6. Upper limit on borrowing for crop production by 30 tenants as set by their landlords, Laguna, 1969.*

	No. of farms	Upper limit (₱/ha)
No borrowing	4	
No upper limit	17	
Upper limit per farm	9	
Upper limit per item:		
a) fertilizer	7	61.17
b) transplanting	6	38.78
c) chemicals	4	16.33
d) land preparation	3	143.66
e) others	2	151.25

* Source: Tenant's survey.

TABLE 7. Yield and input of fertilizer and chemicals per hectare of 29 farms in Laguna, 1968 wet and 1969 dry seasons.*

	Restricted		Unrestricted	
	Number	Amount	Number	Amount
Wet season 1968				
Fertilizer and chemicals (₱)	9	77.39	18	78.33
Yield (cavans)	9	56.32	18	64.35
Dry season, 1969				
Fertilizer and chemicals (₱)	6	53.36	15	105.14
Yield (cavans)	6	64.17	15	78.21

* Source: Tenant's survey.

TABLE 8. Loan by landlords to tenants for specific items, Laguna, 1965 vs. 1969.*

Items	1965		1969	
	No. reporting	Pesos/ ha.	No. reporting	Pesos/ ha.
Fertilizer	18	28.15	24	64.55
Chemicals	10	5.20	23	16.19
Land preparation	0	0	14	108.10
Transplanting	13	33.90	19	52.20
Weeding	4	15.30	10	54.55
Others	1	39.00	9	73.55[a]

* Source: Tenant's survey.

[a] Mostly fuel for irrigation pumps.

TABLE 9. Capital investment on the farm, sources of loan to tenant and ownership of capital items.*

		Purchase date						Sources of loan				Owner				Investment(P)	
Item	No.	Before 1965	1965	1966	1967	1968	1969	Land-lord	Rural banks	Pri-vate	No loan to tenant	Land-lord	Te-nant	Both	Other	Total	Per item
Pump	15	10	1	0	2	1	1	-	-	-	15	13	2	-	-	53,850	3,846
Hand Tractor	4	0	0	2	0	1	1	-	2	-	2	-	3	-	1	13,070	3,268
Carabao	14	6	4	2	2	0	0	3	-	-	10	-	14	-	-	9,355	520
Hand weeder	29	7	9	3	7	2	1	2	-	1	26	4	24	1	1	897	30
Sprayer	15	11	0	1	1	1	1	-	-	1	14	6	8	-	1	1,420	101

*Source: Laguna survey of 30 tenants.

tenant. Most of the farm operators have purchased one or more hand weeders from their own savings.

Both landowners and tenants were asked how they would spend additional funds for the farm operation. The results shown in Table 10 suggest a continuing demand for more fertilizer but less interest in insecticides and weedicides.

With respect to capital investment, the chief demand of the tenant is for a tractor while the landowner is concerned more with the irrigation pump. This difference simply reflects the different responsibilities of the two in the farm sharing arrangement.

3.0 CONCLUSIONS

In the landowner-tenant system as it operates in Laguna, the landowner provides both land and credit to the tenant, who, as farm operator, is largely responsible for deciding the kind and amount of inputs to use. The landowner can and, in some cases, does set an upper limit as to the amount that can be borrowed. However, the majority of the landowners were not themselves limited in terms of available capital. Only a few borrowed from the banks to obtain funds to loan to the tenant.

The supply of credit available for operating expenses appears to be extremely elastic in the situations studied, as evidenced by the changes that occurred between 1965 and 1969. Credit has been increased substantially in all of the major pre-harvest operations.

Purchasing a pump is normally the decision of the landowner who continues to own the pump. However, the landowner seldom extends credit to the tenant for other farm investments such as tractor or carabao.

TABLE 10. How 30 tenants and landowners indicate they would spend additional available funds for the farm.*

	Amount Available			
	For Tenant		For Landowner	
	₱500	₱5,000	₱500	₱5,000
Operating expenses				
Fertilizer	8	-	4	6
Insecticide	5	-	1	2
Weedicide	2	-	1	2
Others	1	1	2	1
Farm implements				
Weeder	7	-	-	-
Sprayer	-	-	-	-
Farm power				
Tractor	3	21	-	3
Carabao	2	1	-	-
Irrigation pump	1	1	2	10
Land	-	2	-	-
Savings	1	3	-	-
Home consumption	5	2	-	1
Others	1	4	-	1

* Source: Tenant and landowner's survey.